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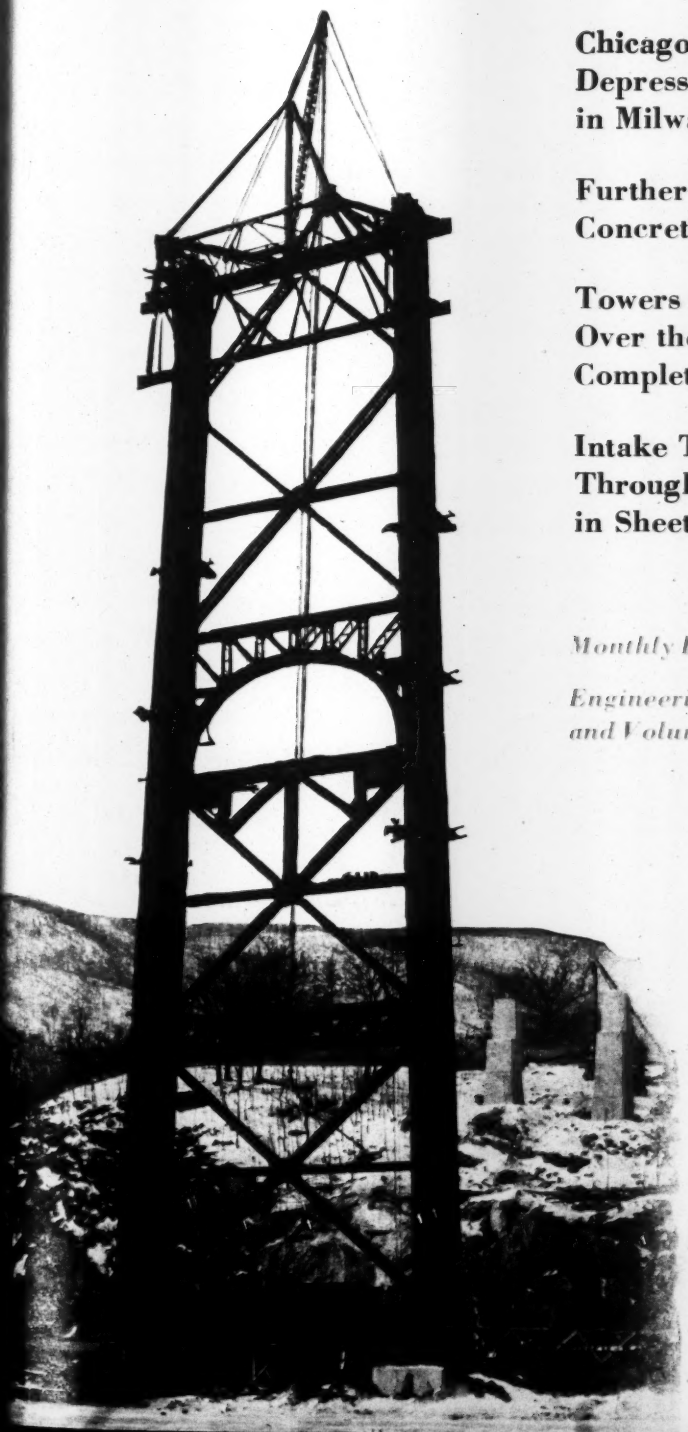

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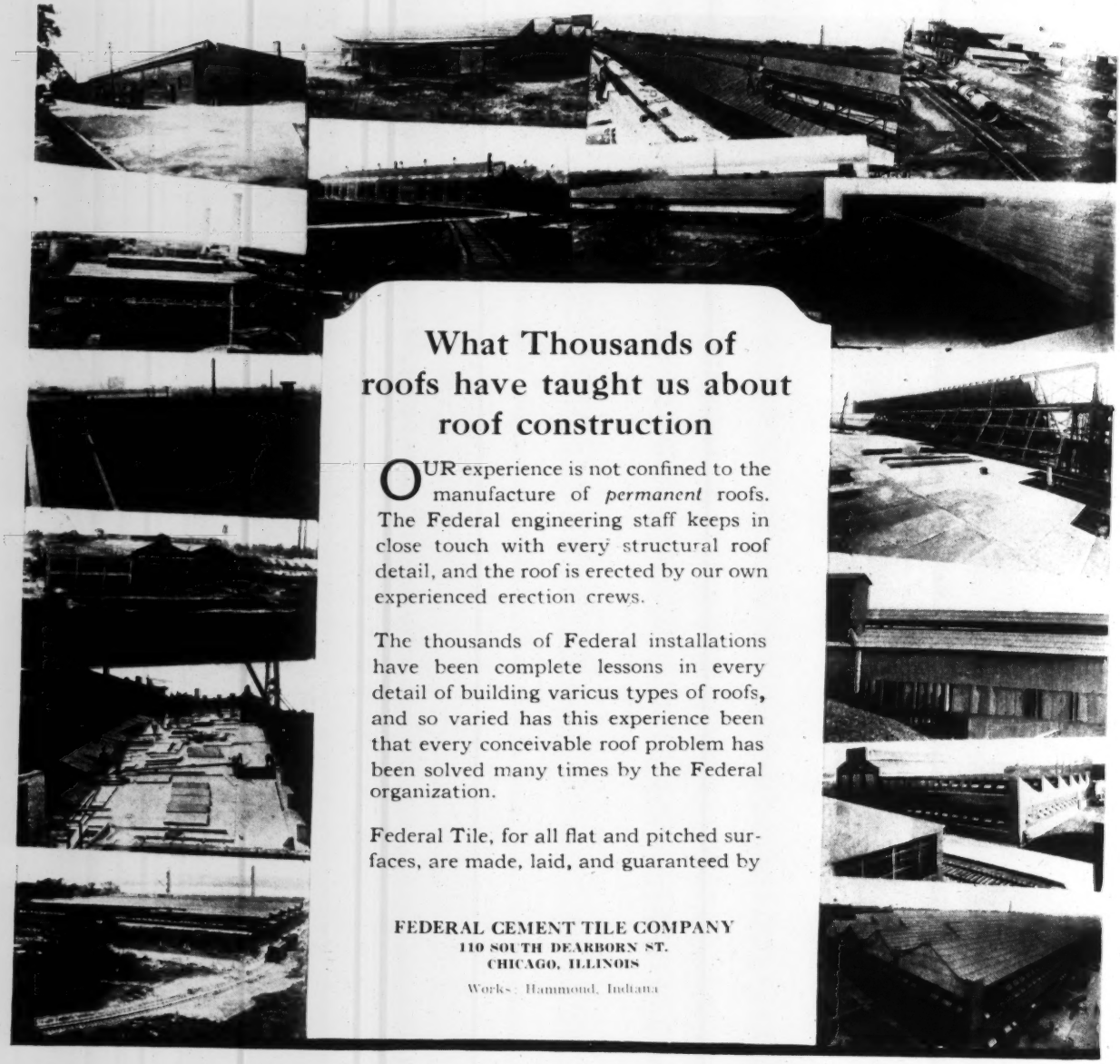

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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

FRANK C. WIGHT
Editor

Volume 92 NEW YORK, APRIL 3, 1924 Number 14

Nelson P. Lewis

AN OUTSTANDING figure among American engineers has joined the immortals. For many years and through the turmoil of changing political administrations Nelson P. Lewis stood unshaken as chief engineer of the largest American city. He was that in fact as well as in name. By virtue of his position, his integrity, his professional ability, his tact, his self-sacrifice and his rare qualities of friendship Mr. Lewis led the municipal engineers of this country. Through this position, combined with his earlier achievements in paving, his work in city planning and his well rounded and evenly balanced judgment in the entire field of municipal engineering, finance and administration, his reputation and influence became international. Aside from his solid basis of knowledge, his good judgment, and his integrity, nothing contributed more to Mr. Lewis' high achievements than his lovable character and his willingness and ability to throw his professional knowledge open to the profession and to the world. By nature and by cultivation he had the art of convincing self expression. This was true of him both as a writer and a public speaker. Self expression is all too rare in the engineer but might be less rare if only diffidence were submerged in that spirit of personal friendship and professional and public service that were the ever impelling motives of Nelson P. Lewis

A Confusion of Questionnaires

CONTRACTORS are likely to have a busy summer answering questionnaires. The engineer who invites his bid, the bank which extends him credit, the surety who underwrites his bond, the dealer who sells him equipment or materials—each has a list of questions which he wants the contractor to answer as a preliminary to the transaction of business. The contractor, because he must, is answering the questions and making, generally, rather a mess of it. Indeed he could not easily do otherwise. No two sets of inquiries are alike, and all contain ambiguous questions. If the several seekers of information were to compare answers they might be warranted in questioning the contractor's sanity as well as his probity. They seldom do this and so the contractor runs little danger. He could, if he wished, even lie with some degree of impunity. In the light of such a situation one is tempted to inquire whereabouts all these questionnaires are really getting us toward establishing contractors' responsibility, for obviously this is their single legitimate excuse. The building public has a right to require that some way shall be sought of measuring the responsibility of the men who seek the work it has to offer. The prevalent questionnaire on experience, equipment and financial standing is the best way that has so far been found. If a clear, explicit, uniform questionnaire would be agreed upon by all users, and one document would easily serve all, it would be really valuable as a means of inquiry. With every agency with which the contractor deals putting questions to him in a different way none gets results which are worth much. Here is a place where the surety bonding business can co-operate with contractors in a really constructive manner.

How to Get Coal Stored

LAST year with another strike staring them in the face, coal consumers listened to obvious words of warning and stocked up heavily in their separate storage places. In consequence the coal load on the railroads was shifted from the peak and, cars being available for the crop movement, the railroads made a record of fall freight handling. No little part of the increased railroad efficiency last year is due to this rational distribution of the demand for coal. Now, however, comes a wail from the coal industry that last year's virtuous reform is being forgotten and coal is being used from storage with a prospect of a later jam in demand and consequently the usual concentrated burden on the railroads at their time of maximum car demand. In other words the coal men are discovering that self interest is a controlling element in coal purchasing just as in everything else. The average consumer is glad to know that the railroads will benefit by early coal ordering and he will admit as an economic truth that what benefits the railroads benefits all the country, but he isn't going to buy coal when he doesn't need it on any such generalizations. If the coal industry really wants to get coal stored it must make some concession in price. The consumer apparently is tired of being always the goat in buying coal.

Circuitous Legislation

LEGISLATIVE mills oftentimes grind small but legislatures can find means of eventually making small grindings into large grists. Witness an act of the New York Legislature of 1923 which is before the present legislature for material enlargement in scope. The first small grinding of the Albany mill applied to compulsory sidewalk construction in "villages of the first or second-class within a county of more than 120,000 and less than 300,000 inhabitants adjoining any city of the first class of over 2,000,000." This elaborate circumlocution restricted the act to Nassau County. The act now before the legislature, by omitting the qualification as to population, etc., becomes applicable to any first or second-class village in the state, of which there are said to be 82. If this act passes, a subsequent legislature need strike out only the qualifying words "first or second class" and the legislation will then become applicable to any village in the state no matter how small. Why not have taken that step in the beginning? A more serious question is whether the legislation itself is sound. The force of

the act, regardless of the size and number of villages to which it applies, lies in its authorizing village trustees to order abutting land owners to construct "a sidewalk of specified width of stone, cement, brick or similar substance at their own expense within thirty days from the time of service" of a notice to that effect. On failure so to do the bill empowers the trustees to build the walk and assess the cost upon the abutting land. Apparentlty then, property owners are denied the customary right of making objections at stated hearings before street or sidewalk improvements of this kind are undertaken. Sidewalks are no longer mere personal conveniences of the property owner, but certainly that owner can expect that there shall be something more than the order of a majority of the city fathers to force him unwillingly to pay for them.

Let Him Without Sin

THE contractors of this country are becoming justly concerned over the great extension of the principle of day labor as opposed to contracts on public work. They would, we suppose, admit that this concern is primarily a matter of enlightened self-interest, but it is also based on honest belief that in the long run the contract system is best for the people who have to pay for public works and who have to use them. There are a number of arguments which bear out the contractors —good, valid arguments which are well known to all who have followed this generation-old question. So long as they keep to these arguments they stand a fair chance of convincing the people—and the elective officers who represent them—that after all the contract system is best. But of late the spokesmen of the contractors have been wandering after strange gods. They are attempting to discredit day labor work by specific examples of improper construction under it and by comparing the contractor's bid for a given construction with the much higher actual cost of the work as actually done by force account. As argument this is puerile. Do contractors always build perfectly? Does a contract job never fail? Do contractors never have extras? Is the finished job always exactly the job called for in the contract plans and specifications? Answer these questions and then consider what an opportunity for reprisals the contractors have left open to the day-labor men.

Fees for Road Openings

AS RURAL roads become of more permanent character, considerations which have long applied to city streets are beginning to prevail on occasions of special uses of highways as trenching for conduits, erecting pole lines, installing gasoline service pumps, building railway crossings and moving buildings. Striking evidence of this development in public roads administration is had in the new Pennsylvania law directing the State Department of Highways to charge fees for permits for work on roads and the publication by the department of a list of fees numbering about a dozen including an advance pavement restoration charge of $9 a square yard. The fees, besides the pavement restoration charge, are based on estimates of the actual cost of issuing the permits and of inspecting the work. There is no purpose of making the procedure a source of income. Nor is there intention of curbing such usual constructions and uses as private driveway entrances, steps and tree planting. It is the purpose only to insure to the public compensation for damaging uses of its highway structure and property. All roads, moreover are included in this protection, not merely state system roads or roads having paved surfaces. This is proper recognition of highway unity and of an obligation of the state extending beyond the limited mileage of its immediate jurisdiction.

Quick Curing Cuts Concrete Road Costs

A PROMISE that the time required to cure a concrete pavement may be cut in half is held out by tests of the Illinois Division of Highways. It is indicated too that in thus reducing the curing time there is no detriment to the strength or soundness of the concrete. If all conclusions, as summarized by H. F. Clemmer in this issue, are correct, their economic significance to concrete road building is very great. Indeed they may reasonably be asserted to surpass in value any gain in knowledge which has in a decade taken place in using concrete as a pavement.

An application of calcium chloride, a mere sprinkling, 2½ lb. a square yard of the dry material, constitutes the new curing process. There is no use of water. And it is necessary that the chemical remains in place only two or three hours; afterwards the pavement may be swept as clean as possible by rain or wind and no harm is done. So much for the process. The action of the chemical is told elsewhere. What is the economic gain? In Illinois last year Mr. Clemmer gives the saving as $900,000 for a thousand-mile concrete road-building program, or $900 a mile. The sources of this saving are not definitely stated but the inference is that they are largely reductions in traffic costs. Does quick curing cut traffic costs?

When we come to estimate traffic savings our measures are rather crude. In practice ordinarily all travel is kept off a concrete road until it has hardened and gained strength for at least four weeks. During this time travelers must make a detour at an extra cost depending upon the number of vehicles, how much longer the detour is and what may be the condition of the road. By the new curing process the curing period is reduced to two weeks. This, we may assume, reduces by the same amount of time the detour period, which, it must not be forgotten, is something quite different from the curing period. Let us put a value to this reduction of the detour period.

An investigation in Wisconsin of the cost of detours, *Engineering News-Record*, June 21, 1923, p. 1088, showed for 159 an average increased distance of travel of 2.15 miles per detour and an average of 81.6 days that each detour was in service. Making a count of traffic at these detours Wisconsin found it to average 1,320 vehicles a day and at 10c. a vehicle mile the cost of all detours was $2.15 \times 81.6 \times 159 \times 1{,}320 \times 10 =$ $3,680,000 in round figures. Assuming that the detour period, 81.6 days should be reduced 14 days, the saving in cost would have been about $625,000, which is an amount in the same category as that computed by Mr. Clemmer for Illinois.

Unquestionably the charges for road construction can be reduced by reducing the period of time the road is out of service and that traffic must be detoured. For concrete roads, calcium chloride curing reduces the detour period about two weeks. It possesses other

economic advantages, if the conclusions of the Illinois tests are substantiated by further experiment and experience. Both should be secured as promptly as possible. Meanwhile the Illinois calcium-chloride concrete curing tests takes a firm place as one of the most useful activities of recent years in highway research.

A Lesson in Cold Weather Concreting

IN THIS issue is presented all that can be discovered regarding the failure of the eight-story reinforced-concrete building frame at Benton Harbor, Mich., last January. Taken with the earlier article which was written immediately after the collapse, the main facts of this celebrated case are now on record. The information regarding the structure is by no means complete; the cement and aggregate tested are not clearly representative, the reported proportioning is not a matter of exact record, the strength of the standing concrete has not been investigated and the fallen concrete tested for strength has not been precisely allocated to the different parts of the structure. It would be valuable to have all of these deficiencies supplied to make assurance as to the cause of the failure doubly sure, but even with these obvious gaps in the history of the building there is enough data available to show that the trouble lay in a too light regard for the dangers inherent in cold weather concreting.

Let us review the case. The building was designed in competent fashion and was being built by an experienced contractor with experienced supervision. The cement is a standard brand and such of it as is available passes the standard specification; there is no other way by which its acceptability can be judged. The aggregate could have been better, but dozens of structures built of it are standing. The proportioning was careless and inaccurate but no more so than in most jobs where the necessity for precise proportioning has not yet penetrated. The chances are that the resulting mixture was leaner than that specified and the optimum strength of such a mix lower than a proper safety factor on the loaded building would require. But even the leaner mix under normal temperature exposure would be expected to attain a strength at least twice that of the strongest piece of concrete taken from the ruins. Calcium chloride was used as an accelerator but there are no valid tests which show that the usual proportion of this salt reduces strength materially. In short, assuming normal temperature, there was no reason for the building to fail.

But it did fail—because it was built in extremely cold weather, with only perfunctory measures for protection against the dangers of low temperature. If no effort whatever had been made to counteract the cold, the Benton Harbor collapse would have been merely an example of criminal ignorance; as it is, it is an example of a little knowledge being a dangerous thing.

Efforts were made to heat the aggregate and water but no one knew just how effective they were; tarpaulins were provided, but they covered, with dangerously wide openings, only one story and had to be moved as soon as a higher floor was placed; salamanders were provided, but they were pitifully few for temperatures far below zero or even for those below freezing. Stories were run up with creditable rapidity even for fair weather, but an extra special effort was apparently made to speed up in the coldest weather, so that we have the fifth story tarpaulin moved to the sixth story three days after the floor between had been placed and in a temperature of 16 deg. below zero. It was only to be expected that this concrete—even with the opportunity for set it might get in the brief intervals of sunshine and warmth—would melt away like ice and collapse when the struts below it were removed on a warmer day.

The dangers of cold weather concreting have been harped on for years. Such a failure as this will do more good to remind engineers and contractors of their actuality than a thousand lectures. But in order to make definite what may be learned some specific facts may be recorded for future reference.

A salamander is not a standard heating unit. To say that so many salamanders per square feet of surface should be used is not to specify precisely. There are possibilities of variation in the stove itself, in its fuel and its rate of fueling, its location and the outside temperature. The only safe precaution is to have thermometers inside the building and constant inspection to see that the heating provided is sufficient to keep the temperature over 55 deg. for four or five days before being subjected to freezing temperature. This involves complete enclosure, which means not only a tight tarpaulin, but one sufficiently far from the outside column to insure air circulation around it and enough tarpaulins so that they do not have to be moved until the concrete they protect is safely set. Steam pipes, if they can be used, are far safer than any salamander, and heat holes leaving openings between stories being curved are an additional precaution.

It goes without saying that water must be heated and aggregate freed of frozen lumps, but it is safer to go further and actually heat the aggregate before it is placed in the mixer. Frozen lumps may get by the steam thawing process and even go through a torch-heated mixer in the minute allowed there. To have safe concrete the whole mix before dumping should be at least 60 deg. in temperature.

These are fairly elementary facts. They are recognized by those who successfully place concrete in cold weather—and the number who do so place it is growing every year. All that is necessary to insure safety is a recognition of the fact that concrete sets but slowly below 50 deg., practically not at all below 40 deg. and absolutely not at all below 32 deg., that frozen or very cold ingredients add to the difficulties of setting whatever the exposure temperature and that repeated freezing and thawing of a partly set concrete permanently reduces its strength. There is much oral testimony to the contrary of the last statement, but tests uniformly bear it out and to go contrary to such tests is merely taking unnecessary chances. The behavior of concrete in cold weather once recognized, there remains only to provide conditions of making and setting which remedy the difficulties. This can be done at a moderately low additional cost, which generally is more than made up by the gains from a continuing construction operation through the cold weather period.

The Benton Harbor building need not discourage builders from going ahead in cold weather; its record, though, might well be posted on every concrete job as a warning of what neglect of any of the proper precautions may lead to.

Further Data on Benton Harbor Concrete Building Failure

Tests Clear Concrete Materials but Show Concrete Itself Very Weak—Inadequate Cold Weather Precautions in Mixing of Concrete and in Protection of Floors After Pouring

INASMUCH as no one was killed or injured in the failure, Jan. 28-30, of the reinforced-concrete building under construction in Benton Harbor, Mich. (*Engineering News-Record*, Feb. 7, 1924, p. 239), there has been no judicial investigation of the accident. Neither is there any building inspection or supervision authority in the city so that an official inquiry is also lacking. Since the failure, however, there have been several non-official investigations of the conditions in the building during construction and some test studies of the concrete materials and the concrete, which taken together add somewhat to the information presented in the article in *Engineering News-Record* by T. L. Condron, consulting engineer, Chicago, written immediately after the collapse, with such data as were then available. The following notes, read in connection with Mr. Condron's article, give all the information regarding the building that it has been possible to collect.

The building, it will be remembered, was to be an eight-story reinforced-concrete structure, 100x100 ft. in plan, with a 56-ft. square corner rising only two stories. When completed it was to have been the Hotel Vincent. Work was started late in November, 1923, and was carried on continuously until Jan. 28, when, the seventh story columns having just been placed and the struts under the fifth floor having just been removed, a collapse started in the fifth floor and continued, more or less continuously, for 30 hours, at the end of which time the structure was in a state of total collapse with the exception of some columns and a part of the first floor. Intensely cold weather extended over practically all the last weeks of the construction and low temperatures during all of the period.

Little can be added to the original report regarding the design. As in most designs, an investigation after the fact shows that there are some minor details which could have been improved, but taken by and large the design is a safe and acceptable one of its type; that is, joist and light floor slab construction with the floor formed by continuous sheet steel domes or inverted channels. The columns were either rodded or spiraled according to the requirements of load. All of the outside columns were rodded for their entire height. The interior columns were spiraled for their lower stories and in some cases where the loads were high, the spirals extended up as high as the fifth story, above which the rodded reinforcement was continued. The girder and beam reinforcement was well placed with thorough provision for continuity over the columns and with hook ties at the dead end of the beams. If this light type of design is considered acceptable for the occupancy expected, the only major criticism that could be made of the design is that it lacks somewhat in thoroughness of horizontal tie both as to spandrel girders and as to cross girders. There might have been a more extensive use of heavier interior girders which would have stiffened the entire frame. However, there is no suggestion that any such corrections of the design would have had any influence whatever upon the safety of the structure under the conditions to which it was subjected.

One interesting feature in the design was the use of heavy steel plate girders spanning the ballroom and lobby openings and attached to reinforced-concrete columns by a vertical row of closely spaced horizontal ¾-in. bolts embedded about 6 in. deep in the concrete column. Although these girders were subjected to the impact of the fall of the upper floors, they remained in place after the collapse. As far as close inspection showed, there was no movement of the girder or of its connection to the columns. There were strut supports under the ends of these girders at the time of the collapse, however.

It should be noted that while the collapse was very extensive and while most of the concrete in the débris was such that as Mr. Condron said, "it can be shoveled and carted away," there is still standing, as shown in the views herewith, a certain number of the columns and lower beams; the light floor is gone everywhere.

As to the materials which went into the concrete and the concrete itself, the best evidences are contained in the following extracts from the report made by the Pittsburgh Testing Laboratory to the contractor:

Samples of all materials used in the work as well as pieces of concrete were selected for testing. The results of the tests are as follows:

Water—The water used in the concrete was taken from the city mains. This water was used in mixing mortar briquettes made of portland cement and standard Ottawa sand and checked against the same materials mixed with distilled water.

TENSILE STRENGTH—7 DAYS

Distilled Water	Benton Harbor City Water
(a) 200	215
(b) 200	245
(c) 230	225
Av. 210	228

This test shows that there is nothing in the mixing water that would affect the strength or setting time of the concrete.

Sand—A sample of sand was taken from the stockpile beneath the sidewalk. Analysis showed the following:

SIEVE ANALYSIS

Sieve Number	Size Opening—Inches	Per Cent Passing
¼	0.375	100
4	.185	81.8
8	.093	59.6
14	.046	41.2
28	.0232	27.1
48	.0116	9.0
100	.0055	1.9

Clay and silt by washing—per cent	2.8
Colorimetric test for organic impurities—plate 2	O.K.

COMPRESSIVE STRENGTH—POUNDS PER SQUARE INCH

2 x 4 in. Cylinders Mix 1:3 by Volume, 7-Day

Standard Ottawa Sand	This Sand
(a) 750	1050
(b) 790	1380
(c) 720	1320
Av. 753	1253
Strength Ratio at 7-Days	167%

These tests show that the sand now on the job is of excellent quality. Sand used in all of the concrete work came from the same source of supply. Therefore, it is improbable that the sand affected the strength or setting time of the concrete.

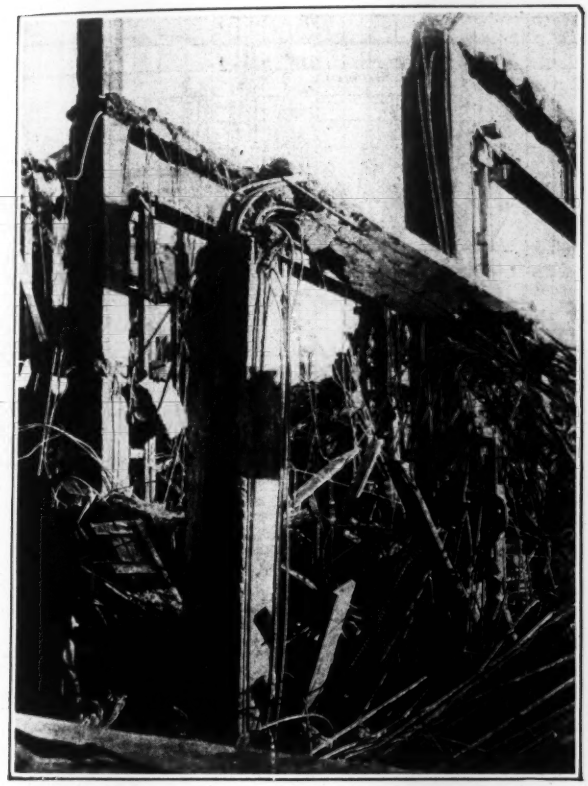
Stone—The crushed stone still on the job was of good quality. It contained some fine dust, but it came off of the stone very easily and would not form a coating around the individual pieces.

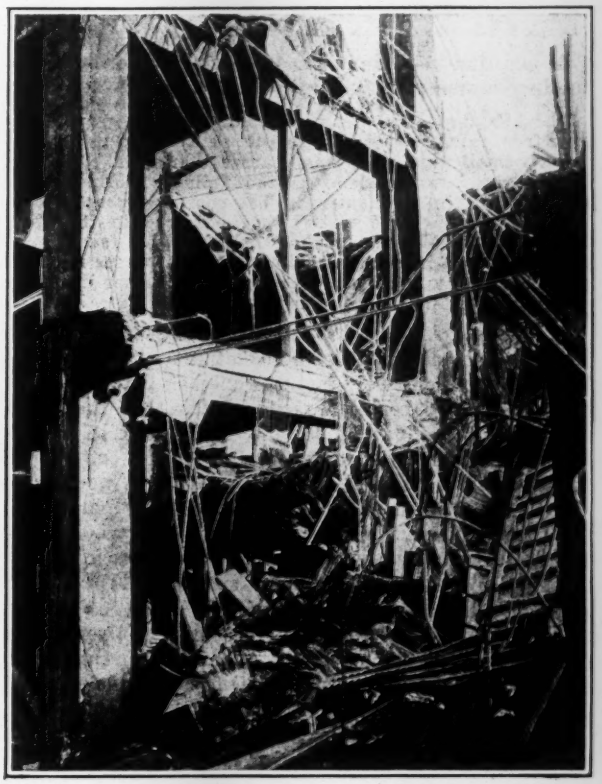
SCREEN ANALYSIS

Screen Size—Inches	Per Cent Passing
1½	100.
1	82.1
½	29.4
¼	4.4

This stone is slightly coarser than called for in the specifications, but the grading would not affect the setting of the concrete. Coarse stone would have the tendency to increase the strength of the concrete.

Some gravel had been used in the concrete on the first floor but none of it was available for test. It was apparently of good quality, judging from its appearance in the concrete.





TWO VIEWS OF LOWER STORIES OF COLLAPSED CONCRETE BUILDING AT BENTON HARBOR

At left: Note the steel plate-girders supporting ballroom roof and columns for upper stories still in place. At right: Note the form of beam reinforcement in stripped beam in foreground.

Cement—Four samples of Michigan cement were selected for test from that still remaining in the basement. No Alpha cement could be located as the cement was nearly covered by débris. Three of these samples were taken by a committee of citizens from Benton Harbor. They are marked "A", "B" and "C". The fourth sample came from two bags selected by the superintendent and was marked "D".

Tests of the cement were made in accordance with the methods prescribed by the American Society for Testing Materials. Results of tests are as follows:

Mark		"A"	"B"	"C"	"D"
Setting time, Initial		3 hr. 10 min.	3 hr. 15 min.	2 hr. 55 min.	6 hr. 55 min.
Final		4 hr. 50 min.	4 hr. 45 min.	4 hr. 25 min.	Over 8 hrs.
Retained on 200 mesh sieve, per cent		17.7	20.6	15.1	17.4
Constancy of volume in steam		O. K.	O. K.	O. K.	O. K.
Tensile strength, 7 days, Lb. per square inch	(a)	255	175	250	185
	(b)	220	200	245	210
	(c)	230	190	265	185
Average		235	188	253	193

These samples meet the requirements of the specifications with the exception of samples "B" and "D" which are a little low in tensile strength. The requirement is 200 lb. at 7 days. Sample "D" is so close to the limit that it would ordinarily be accepted. There is considerable variation in the cement as shown in its fineness, setting time, and tensile strength. The tensile strength is not low enough to cause failure of the concrete and the setting time is not longer than that of many cements which have been used in concrete with satisfactory results.

Concrete—In order to determine the relation between the amount of sand and crushed stone used, some of the concrete which had not set was taken from the forms for screening. The samples were selected in the presence of the superintendent and represented the average concrete. The concrete was divided on the ¼-in. screen; all material passing this screen being called sand and cement.

Location of Sample	Per Cent Passing ¼-in. Screen	Average
From beam near the elevator shaft	49.0	
	51.8	50.4
From column near southeast corner	52.4	
	50.7	51.5

The sand used in this concrete weighs about 110 lb. per cubic foot, the stone about 95 lb. per cubic foot, and the cement 94 lb. per cubic foot. One cubic foot (bag) of cement mixed with two cubic feet of sand and four cubic feet of stone will result in approximately 4.5 cubic feet of concrete weighing 694 lb. Of this concrete, 314 lb., or 45 per cent, is sand and cement. The average percentage of sand and cement as determined above is 51 per cent, or an excess of 6 per cent, which is probably all sand. Such a small excess of sand would not have much effect on the strength of the concrete and it certainly would not affect its setting.

Compressive Strength of the Concrete—Due to the almost complete breaking up of the concrete, it was difficult to find pieces large enough for compression tests. Five samples were obtained, mostly from the interior of columns. It was practically impossible to locate the exact source of the samples and therefore impossible to tell the age of the

concrete at time of testing. Compression tests were made on Feb. 9. The results of the compression tests were as follows:

TESTS OF CONCRETE FROM VINCENT HOTEL BUILDING

Mark	Coarse Aggregate	Size of Specimen In.	Sectional Area Sq. In.	Crushing Load Lb.	Crushing Strength Lb. per sq. in.
1	Gravel	10.0x9.5x13.75	95.0	40,400	425
2	Gravel	10.0x10.5x8.50	105.0	75,450	718
3	Stone	7.4x9.5x12.0	70.3	32,100*	456
4	Stone	9.5x9.0x12.5	85.5	21,150	247
5	Stone	8.8x7.9x8.0	69.5	17,930	258

* Specimen showed a slight crack before testing.
Samples one and two taken from near southeast corner, probably from columns between first and second floors.
Sample three from near southwest corner.
Sample four from column probably between sixth and seventh floors.
Sample five from beam near southwest corner.

In addition to this report, a report has been made by another engineer as follows:

The fine aggregate was river sand and fine gravel running from fairly coarse sand to ¼-in. pebbles and larger, but a very small part of it was coarser than ¼ in. Some of the concrete inspected after the failure shows pebbles more than 1 in. in diameter. The coarse aggregate consisted of such coarse material as occurred in the river sand and gravel and crushed limestone of fairly good grading up to 1 in. with a small amount of coarser material up to 1½ in. A considerable amount of crusher dust was noticeable in the crushed stone.

The proportioning was done with wheelbarrows and there is some doubt as to the exactness with which the 1:2:4 proportions were met. A one-bag batch mix was used and one interested party states that the batch consisted of one bag of cement, two struck off wheelbarrow loads of river sand and gravel, and one heaped up wheelbarrow load of crushed stone, which would give about one part cement, four parts river sand and gravel, and three parts crushed stone. There is no way now of telling just how close this 1:4:3 mix approached the strength requirement of the specified 1:2:4 mix. Another authentic report is that 1,954 bbl. of cement and 1,615 cu.yd. of aggregate had been delivered and practically all used, or 1.21 bbl. of cement per cubic yard of aggregate. This would indicate a deficiency of cement by the specifications aimed at.

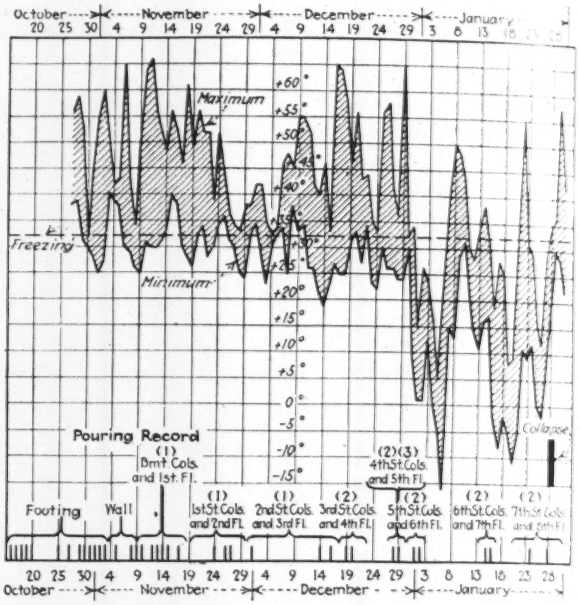
The amount of water used is described as that which gave a quaky mix. No better or more accurate description can be found.

With regard to precautions for heating the concrete, water was heated and the aggregate thawed out with steam pipes. From the fourth floor up an oil burner was kept burning in the mixer. No record was kept of the temperature of the mixed concrete, however. In addition to heating the concrete calcium chloride solution was added to the concrete, as stated by Mr. Condron in the previous article. There is a discrepancy in the reports as to amounts used, however.

Mr. Condron was informed that 16 quarts of crystals were used per barrel of water. This would be about 4 per cent by weight. The Pittsburgh Testing Laboratory reports that calcium chloride was used apparently at the rate of 1 qt. to the batch, the solution being made by dissolving 18 qt. of crystalline calcium chloride in a barrel of water. Floor protection during the cold weather consisted of sufficient tarpaulin to inclose one story only, together with 16 salamanders for the whole job. Apparently the tarpaulins were kept up and the salamanders kept going for a maximum of three or four days on any one story, and had to be moved from story to story as the work went along. The pictures show that the tarpaulins the day of the collapse were above the floor where the collapse occurred.

In connection with the evidence presented above, it seems worth while to reproduce here again the temperature chart published in the earlier article, together with the following extracts from the report on the failure by A. C. Irwin, structural engineer of the Portland Cement Association:

Two working days only intervened between termination of concreting the fifth floor and beginning work on the next story above. Tarpaulins for *one story* only were available. The day when the fifth story was completed, the temperaure reached a maximum of 65 deg. F. Was the



(1) Water heated.
(2) Water and aggregates heated by steam jets, also 16 salamanders used under floor and story below enclosed by tarpaulins, calcium chloride used.
(3) Forms under 5th floor removed Jan. 28. Collapse started at 5th floor 9 p.m., Jan. 28, and completed 12 p.m., Jan. 29.

TEMPERATURE RECORD OF THE BENTON HARBOR BUILDING CONSTRUCTION
Reprinted from Engineering News-Record, Feb. 7, 1924.

fourth story and fifth floor enclosed with tarpaulins with such balmy weather conditions? If we assume that the tarpaulins were up for the fourth story and fifth floor at the beginning of concreting them, then we must admit that these tarpaulins were taken from the fourth story and fifth floor to the fifth story and sixth floor during the days of Dec. 30 and 31, just prior to the zero temperatures on Jan. 1. In other words, the fifth floor and fourth story columns were exposed to zero temperatures in less than 48 hours after completion. Further, the chart shows continually falling temperature from the date of completion of the fifth floor.

Let us recall the type of construction. The concrete over the steel domes was 2 in. thick, and the joists 5 in. thick. There can be no question but that all of this concrete became very cold and it is a practical certainty that it was frozen through. Moreover, it was subjected to alternate freezing and thawing four times before the shores were pulled from the fourth story, just previous to collapse of the fifth floor. This floor was obviously not only frozen through, but the alternate freezing and thawing to which it was subjected effectively prevented it from gaining appreciable strength.

Referring to the temperature record, the fifth story columns and sixth floor were cast during very cold weather followed by a recorded temperature of 16 deg. below zero. One salamander was provided for each 450 sq.ft. of floor area approximately. Experience has shown that one salamander is required for each 300 sq.ft. of floor, and that for temperatures around zero, two additional salamanders should be provided at each exterior column. This structure

had 25 exterior columns. The 16 salamanders on the job were about one-fourth as many as required for safe protection under the unusual weather conditions. The seventh and eighth floors were cast just prior to the occurrence of below zero temperatures. The absence of sufficient salamanders and the temperatures existing make it certain that the outside columns were frozen and alternately subjected to freezing and thawing, and that none of the concrete had an opportunity really to harden. Thus, when the support afforded the shores was removed by failure of the fifth floor, the collapse of the sixth, seventh and eighth floors is amply accounted for.

The average temperatures, shown in the figure, for November and December, during construction of the first four stories, was between 35 deg. and 40 deg. F. The average temperatures in the building could not have been higher than 32 deg. F., since the curves shown are the result of temperature reading on the south side of a building.

In Bulletin 81, Engineering Experiment Station, University of Illinois, entitled "Influence of Temperature on the Strength of Concrete," are curves which are the result of actual tests and which are recommended by the author of the bulletin for estimating the strength of concrete cured under relatively low temperatures. It should be noted that the tests on which these curves are based did not include alternate freezing and thawing. However, some tests were made which indicate the effect on fresh concrete of alternate freezing and thawing. The following is quoted from the bulletin: "The results of Set F indicate that the low temperature retarded the hardening action of the concrete, and that the alternations above and below freezing caused a softening and crumbling of the material."

Remembering that the concrete over the steel domes was only 2 in. thick and that the joists were only 5 in. thick and exposed on three sides, we cannot escape the conclusion that the concrete was subjected to alternate freezing and thawing. This, in itself, is sufficient to explain the lack of strength of the concrete, but we can be still more definite.

The figure shows that for 73.1 per cent of the days between concreting the footings and the fourth floor, temperatures below freezing were experienced, and that for several consecutive days the average temperature was below 32 deg. F.

By interpolation from the Illinois curves we obtain a percentage of 60 per cent of normal strength at 28 days for concrete kept at around freezing, but not alternately frozen and thawed. The average strength at 28 days of the specimens subjected to alternate freezing and thawing were found to be less than 500 lb. per square inch and some were too weak to be tested. We may conclude that the concrete surrounding the reinforcement bars which, of course, were relatively near the surface was so affected by alternate freezing and thawing that the bond of the concrete on the bars was very low. It is obvious that if the concrete afforded very little bond with the bars, the reinforcement did not function as such. The temperature conditions were such as to prevent the surface concrete from obtaining any appreciable strength or bond with the bars and the collapse of the lower floors under the additional load of the collapsed upper floors was to be expected.

As noted above, concrete kept at a temperature slightly above freezing may be expected to develop not to exceed 60 per cent of the normal strength at 28 days, and fresh concrete subjected to alternate freezing and thawing does not acquire very much, if any, strength. The temperature chart shows that the concrete in the lower stories *was* subjected to freezing and thawing because for 73 per cent of the days, temperatures below freezing were experienced. If we assume that the freezing and thawing action penetrated the ribs 1 in. on all exposed surfaces the remaining section would be less than 50 per cent of the original. Remembering also that the strength of a beam varies as the square of the depth, the reduction in "effective" depth due to surface freezing and thawing would further reduce materially the load carrying capacity of the ribs. We may therefore conclude that the ribs did not possess as much as one-fourth the load carrying capacity that they would be expected to have under proper curing conditions.

The dead-load of each floor amounted to about 50 lb. per square foot, so that when the fifth floor fell upon the fourth floor, the latter was loaded practically to the point of failure. The collapse of the fourth floor under the weight of the material from the upper floors would at once very greatly overload the third and succeeding floors so that the collapse would continue to the first floor. This is exactly what happened.

Portions of the first floor did not fail even under the weight of the wreckage. This floor and the basement columns had a much better opportunity to harden than any of the floors above. The mixing was done in the basement and the water heated there. The basement walls afforded enclosure and of course the entire basement is mostly below grade. The sand was stored in the basement and heating operations carried on there afforded considerable warmth. Taking all these conditions into consideration, we can conclude that the basement columns and first floor had a very fair opportunity to gain strength. The second, third and fourth floors had no such opportunity and if the material had all been of first class quality the conditions of curing were so unfavorable as to make their failure inevitable under the loads of the collapsed floors above.

Japan Railway Tunnels and the Earthquake

IN THE great earthquake in Japan last year the construction work for the new Atami low-grade cutoff with its 5-mile Tanna-san tunnel, on the Tokyo-Kobe line of the Japanese Government Railways, sustained severe damage, being near the center of the earthquake shock. This line and its large rock tunnel were described in *Engineering News-Record*, March 9, 1922, p. 394. Parts of the track built along steep cliffs fronting on the sea were carried away bodily by landslips, no trace of the roadbed being left. Some of the shorter tunnels were seriously damaged, but those south of the Izumigoe tunnel (8,060 ft.), about two miles north of the Tanna-san tunnel, sustained only slight damage. Fortunately, there were comparatively few casualties among the engineers and workmen in the several tunnels on the Atami line.

PROGRESS ON TANNA-SAN TUNNEL; JAPAN
Total length, 25,614 ft; 4.86 miles
Date of Record, Sept 1, 1923

	From West Portal		From East Portal	
	Feet	Miles	Feet	Miles
Heading excavated	5,113	0.968	5,900	1.116
Side wall finished	4,768	0.903	4,078	0.772
Arch ring finished	4,768	0.903	4,028	0.762

Tanna-san Tunnel—This large tunnel was but little affected by the earthquake and construction work was soon renewed, but the amount of water encountered has retarded its progress. Since June, 1923, there have been heavy inrushes of water, amounting to 20 cu.ft. per second, and since the position of the spouts changes as the work advances, there has been considerable delay due to taking care of this difficulty. This slow progress is indicated by the record in the accompanying table.

Other Tunnels—Including the tunnels on the Atami line and on operated lines there were seventy-one railway tunnels in the earthquake district, with a total length of 68,465 ft. Of these, thirty-six were damaged, the length of the damaged portions aggregating 4,624 ft.

Narrow Gage Railways of South Africa

The annual report of the railways of the Union of South Africa for the year ending March 31, 1923, gives the total mileage as 10,986. All of these railroads are narrow gage, either 3 ft. 6 in. or 2 ft. Their estimated cost to date is over $481,000,000, or approximately $44,000 a mile.

Intake Tunnel Through New Orleans Levee In Sheetpile Cofferdam

Excavation in Soft Ground Under Hydrostatic Heads Up to 33 Ft. In Short Sections Within Steel Sheeting —Close Bracing Required to Prevent Bulging—Sheeting Deflected By Logs

BY RALPH H. CHAMBERS
Jarrett-Chambers Co. Inc., Consulting and Constructing Engineers, New York

DURING the past year an intake tunnel for condensing water was constructed through the Mississippi River levee at the power plant of the New Orleans Public Service, Inc., which operates the electric railways and other public utilities of the city of New Orleans. This work was necessary in order to increase the power production of the plant. Its interest lies in the fact that it was constructed in the saturated and unstable soil of New Orleans, alongside a heavy power house building, under six railroad tracks carrying a heavy traffic, and through the levee which protects the city from high water of the Mississippi River. It may be instructive to compare the methods used in its construction with those employed in other deep excavations made in the same region.

Location—The power house is located at South Peters and Market Sts., on the eastern limb of the crescent of the Mississippi River, where the river is flowing almost north. A reference to Fig. 1 will show the location of the tunnel with regard to the power house, the railroad tracks, the levee and the other features of the location. The inboard end of the tunnel is about 400 ft. inland from the bank of the river, while the river end is on the submerged bank or "batture" of the levee. The inboard end, in Market St. is a header about 172 ft. long provided with suction chambers for six suction conduits. At the east end of this header and running at right angles to it, a tunnel 43 ft. long connects with a screen chamber, 29 x 31.5 ft., which is essentially a well provided with revolving screens. From the screen well the tunnel runs almost due east about 283 ft., under six railroad tracks, through the levee and out to the intake structure in the river. The tunnel is 10 x 10 ft. in normal cross-section and about 530 ft. long; its invert is 15 ft. below the lowest recorded water level, 29 ft. below Market St. and about 36 ft. below the top of the levee, and the maximum depth of excavation was about 38 ft.

General Subsoil Conditions—New Orleans is built upon an alluvial plain which, as is well known, is for a considerable portion of the year below the level of the river. Borings have been made in several parts of the city to a depth of 1,300 ft. without reaching rock, and these borings have shown that this whole region has quite uniform subsurface conditions. The subsoil consists of alternate layers of clay and sand varying only in the thickness of the alternate strata. The clay layers are yellow or blue clay, moist and sticky and the sand varies from coarse sand to quicksand. The whole, saturated, is under hydrostatic pressure.

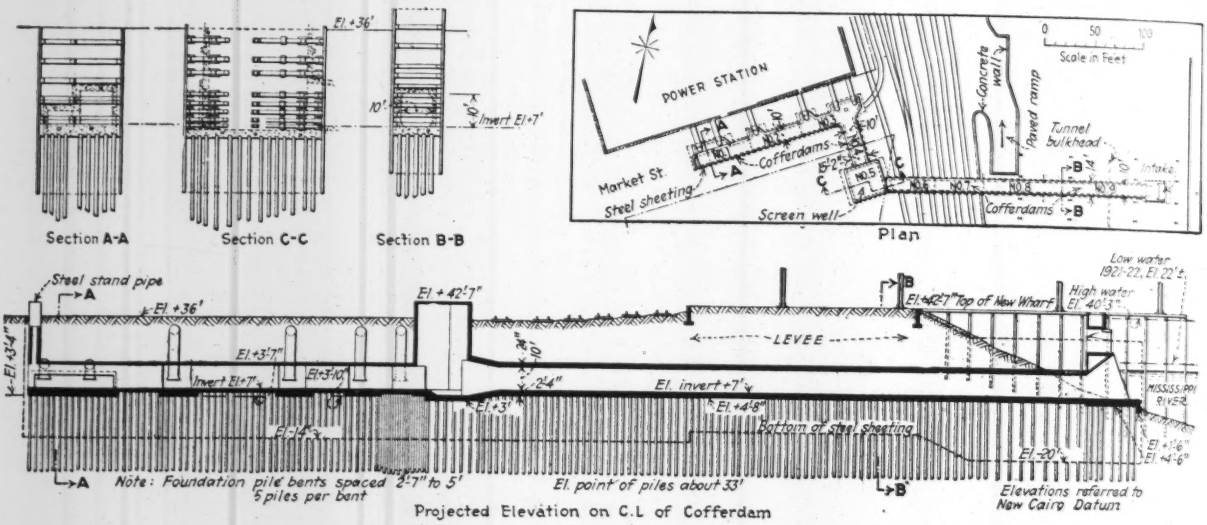


FIG. 1—PLAN AND SECTIONS OF INTAKE TUNNEL AND COFFERDAMS

Previous Excavations—In general, deep excavations in New Orleans are avoided. The heavy buildings are on pile foundations. Some excavations have been made, but not to the depth required for this work except in the case of the excavations made for the Inner Harbor Navigation Canal, recently built, and in particular for the lock for that canal. A short review of the expedients that were used will illustrate the unstable character of the subsoil of that region.

The lock structure occupies an area 190 x 1,135 ft., and the bottom of the structure is 47 ft. below the original ground surface. The engineers decided that it would not be feasible to enclose this area in a single cofferdam and to excavate to grade within this cofferdam. The site of the lock is about 2,000 ft. from the river, but the excavation for the canal had been pushed forward from the Lake Ponchartrain end until the dredges had reached the site of the lock. These dredges

were used to excavate the lock site to the required grade with slopes on all sides of 4 to 1. Thus the area excavated was about 565 x 1,500 ft., and about 19.5 acres in extent (fortunately in an unbuilt-up section). The entire area which had been dredged was surrounded by a timber sheetpile cofferdam 48 ft. deep and about 4,000 ft. long, and a bulkhead and dike were built to

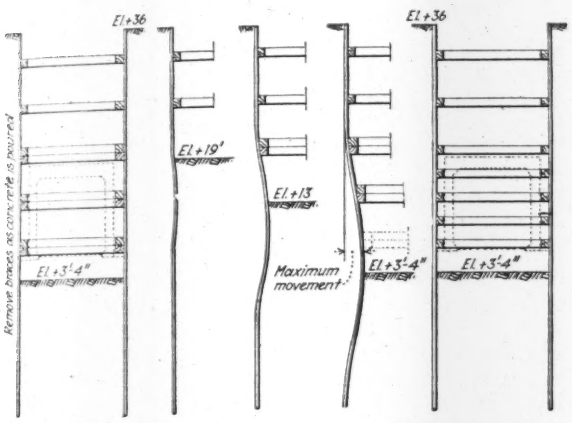


FIG. 2—HOW SHEETING BULGED WHEN WIDE SPACING OF BRACES WAS USED

cut off the lock site from the canal. The water on the site was then pumped down to a level about 22 ft. below the original ground surface and a second and concentric timber cofferdam 50 ft. deep and about 3,100 ft. long was constructed, its top about 21 ft. below the original ground surface. After the completion of this work an attempt to unwater the site proved unsuccessful, and a third concentric cofferdam of steel sheeting, 50 ft. deep and 2,650 ft. long, was driven around the outside lines of the proposed lock masonry. Also 186 steel-pipe wells 10 in. in diameter and 55 ft. long were driven, 130 just within the lines of the steel sheetpiling and 56 on both sides of the inner wooden cofferdam. By long-continued pumping from these wells to relieve the hydrostatic pressure on the underlying quicksand strata the innermost cofferdam was successfully unwatered and braced. These excavation and unwatering operations required fourteen months for their completion.

Thus, to excavate and unwater the actual space to be occupied by the lock, about five times the area of the lock was occupied, 2½ times the net volume of earth was excavated, three concentric cofferdams equal to 3½ times the perimeter of the lock were constructed, 186 pipe wells were driven and pumped, and fourteen months' time was consumed.

During the period when this work was in progress the river level was at El. 33, but on the site of the lock the maximum height to which the water rose in the pipe wells was 22 ft. lower, apparently therefore the hydrostatic head above the grade level of the excavation was 33 ft.

Method of Procedure—It was decided that on account of the irregular section of the intake tunnel the work would have to be done, if possible, by open excavation. As already stated the maximum depth of excavation which would be required was 38 ft., that is, 9 ft. less that the depth of the excavation for the lock. On the other hand, as the surface of the river at that time and during the greater part of the time this work was in progress was about level with Market St., the hydrostatic head above the bottom of the excavation was 33 ft., that is, the same as the head at the lock. As already mentioned the site of the tunnel was immediately adjacent to the power house and other structures, and therefore the methods used at the lock could not be used at this site. Furthermore the location of the site, practically on the river bank, made the use of wells to relieve the pressure on the underlying strata of doubtful value.

The expedient which was adopted and which proved successful in this work was to do this work in open cofferdams using steel sheetpiling, and to drive the sheetpiling to a sufficient depth below the final grade of the excavations to cut off the hydrostatic pressure in the soil immediately below the bottoms of the excavations and to enter one or more of the clay strata which alternate with the quicksand strata. Furthermore it was recognized that this method had an additional chance of success because the cofferdams would be of comparatively small width. To take still further advantage of this idea it was determined to divide up the work into short cofferdams, using sheetpile bulkheads driven to the same depth as the sides of the cofferdams.

General Description—Accordingly the tunnel excavation was divided into nine sections enclosed by nine cofferdams, as shown by Fig. 1. The dimensions of these cofferdams varied, as shown, up to a maximum of 24.5 x 63 ft. for cofferdam 3, 36 x 43 ft. for cofferdam 5, and 14 x 98 ft. for cofferdam 9.

Except for cofferdam 9 the plant used for the driving of the steel sheetpiling consisted of three traveling derricks with double-acting steam pile hammers. The

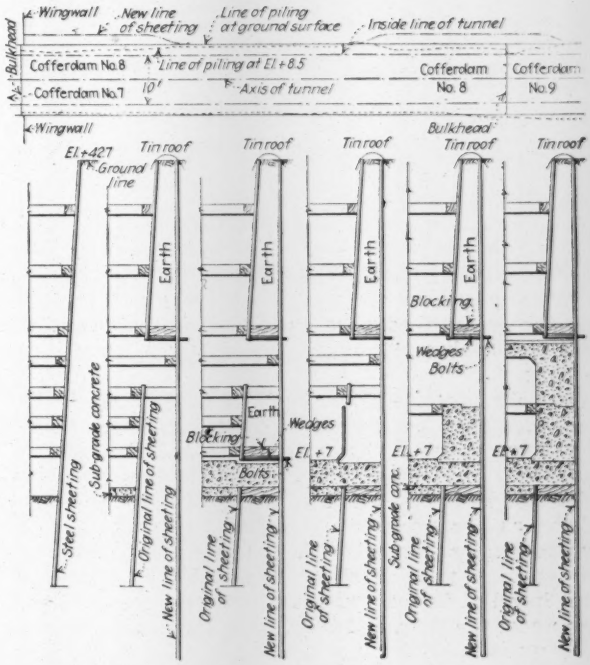


FIG. 3—METHOD USED WHERE SHEETING WAS DEFLECTED BY LOGS

same derricks were used for the excavation, which was done by clamshell buckets, and for driving the wooden piles. These piles, however, were driven by a single-acting steam pile hammer in swinging leads. Both the steel and the wood piling in cofferdam 9 were driven

by a turntable driver with a single-acting steam pile hammer, and the excavation in this cofferdam was done by jetting and pumping into the river. The crossing under the railroad tracks was accomplished by cutting out one track at a time, driving the steel and wooden piling across the line of the track and installing a steel beam bridge upon which the new track was laid. When the sheeting for the cofferdam under the tracks had been completed and the tracks restored in the manner mentioned, these cofferdams were excavated and braced and the concrete tunnel was constructed, working under the track bridges.

The steel sheetpiling used in cofferdams 1 to 5 inclusive was pulled after the tunnel in these cofferdams was completed and the cofferdams had been backfilled.

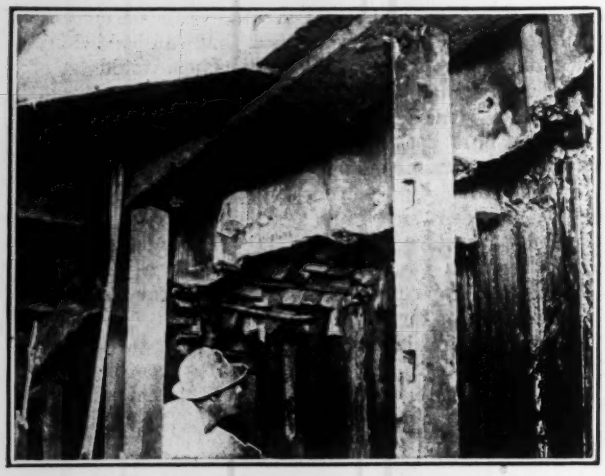


FIG. 4—SPACE BETWEEN OLD AND NEW SHEETING ROOFED WITH BLOCKING AND WEDGES

Double-acting steam hammers were used to pull it. The steel sheetpiling in the other cofferdams was left in place and two sheetpile wingwalls were driven under the levee as shown in Fig. 1.

The wooden piles were in general 40 ft. long. These were driven after the excavations were completed or nearly completed except in cofferdams 6 to 9 inclusive. In these cofferdams the wooden piling was driven before the excavations were made and the butts of the piles were driven 18 to 20 ft. below the ground or water surface by the use of followers.

Behavior of Soil—Cofferdam 1 was the first to be excavated. The excavation and bracing Sketch A in Fig. 2 were carried down to grade and the wooden foundation piles were then driven. At this time the quicksand began to flow into the excavation in large volume as the necessary pumping was done, and it became necessary to put in the concrete floor in sections and as rapidly as possible. Weepholes of iron pipe were installed in the concrete floor to relieve the pressure under the floor, and these were afterwards capped.

As a result of the experience gained, a change was made in the methods of excavation and bracing in the work which followed. As originally designed the lower bracing was in double sets, 6 ft. center to center vertically, and was designed for a lateral pressure on the sides of the cofferdam of 70 lb. per foot of depth below the ground surface. The braces were spaced so far apart vertically in order to interfere as little as possible with the concrete tunnel to be installed. In cofferdam 1 it was found that, as the excavation proceeded, the sheetpiling moved into the cofferdam, and this movement reached a maximum of 2 ft. at one point in the bottom of this cofferdam. Sketches B, C and D in Fig. 2 show how the sheeting bent inward as the excavation proceeded and before each set of bracing could be placed, E in Fig. 2 shows how the difficulty was surmounted by limiting the excavation to a maximum of 3 ft. below each set of bracing until after the next set had been installed.

To overcome the trouble with flowing quicksand it was decided to stop the excavation and bracing 10 ft. above grade until the wooden piles had been driven. The excavation was then completed in short sections and the wooden piles were cut off and the concrete floor was poured in each section before the excavation of the next section was begun. Some of the cofferdams were much dryer than others, and in the former the excavation was carried to grade before the wooden piles were driven. As already mentioned, the wooden piles in cofferdams 6 to 9 inclusive were driven before any excavation was done in these cofferdams.

Widening Cofferdam—In cofferdams 8 and 9 the steel sheeting encroached upon the net width required on account of the fact that the sheeting was deflected by sunken logs and timbers. This trouble was not fully evident until the excavation and bracing of these cofferdams had been practically completed. At that time it was not practicable to pull and redrive the sheeting, and therefore the plan described in the following was adopted.

The plan in Fig. 3 shows the location of the steel sheeting in these cofferdams at the ground surface and at a level just above the tunnel invert. It will be seen that at the bottom the sheeting encroaches upon the space required for the walls of the tunnel. To provide more lateral space in these cofferdams at the bottom, a new line of sheeting was driven outside of the original line and a sufficient distance from the original line to give the required lateral space and to make sure that the second line of sheeting would not be deflected by obstructions as much as was the first line. The second line of sheeting was lapped with the original sheeting at the ends. The first line of sheeting was then cut out at the bottom of the cofferdams, by oxyacetylene torches. This work was done in sections in order to brace the new sheeting as the work proceeded. Finally the whole of the lower part of the deflected sheeting was removed and the concrete tunnel was poured against the new sheeting. The space between the new and the original sheeting was roofed over to prevent access of water, and the earth between the two lines was supported above the level of the tunnel roof. The sections in Fig. 3 show the details of this work. This work was carried out without any difficulty or delay. The photograph Fig. 4 shows the inside face of the new sheeting after removal of the old.

From the beginning of the work on this project until its completion, no serious delay was encountered and the work was entirely successful. The work was begun at the end of March, 1923, and the concrete tunnel was completed at the end of September, 1923. It was carried out for the New Orleans Public Service, Inc., H. B. Flowers, president, under a contract with The Phoenix Utility Co., Clyde A. Pratt, president. The detailed construction plans were made by Jarrett-Chambers Co., Inc., of New York, and the work was done by that company, S. C. Hulse being superintendent of construction.

Sand Bed Studies at Montebello Water Filters—II

Discussion—by H. E Babbitt, Philip Burgess, C. M. Daily, W. Donaldson, J. W. Ellms, J. B. Hawley, W. F. Langelier, Dabney H. Maury, Leonard Metcalf and F. H. Waring—of John R. Baylis' article in *Engineering News-Record*, March 27, 1924, and a Reply to the Discussion by Mr. Baylis

Chlorine Cheaper Than Top Jets for Iron Removal Filters

By H. E. Babbitt
Professor of Sanitary Engineering, University of Illinois, Urbana, Ill.

MANY of the troubles caused by cracking of the sand beds in the iron removal filters of the Champaign-Urbana Water Co., due to a gelatinous coating on the sand grains, have been overcome by the use of generous quantities of chlorine. The amount now in use is about 1 p.p.m. which is applied before filtration. No troubles have been reported from taste and odor as a result of the use of this amount of chlorine, although last fall an overdose of chlorine, put in the clear-water basin, resulted in widespread and prolonged complaints.

It is true that the gelatinous film found on the sand here is probably different in character from that found on the Baltimore sand. No coagulating chemical is used, the "coagulant" being mainly ferric hydroxide formed by the aeration of the water on entering the receiving reservoir and again when put on the filters. Hence the success of chlorine does not disprove the statement that chlorine under the Baltimore conditions was not a success.

Before chlorine was used, other methods of breaking up the sand bed were attempted, including series of jets somewhat like those described by Mr. Baylis. Although partly successful, the amount of water required for the jets was so great as to render their use uneconomical. Another attempt was the blowing of live steam into the sand. A stinking brew was cooked up that smelled to Heaven. One trial was sufficient.

As a suggestion, the difficulty encountered from the drawing of the sand away from the side walls might be overcome by building these walls sloping instead of vertical.

* * *

Top Washing Beneficial but Baltimore Sand and Underdrains Questioned

By Philip Burgess
Consulting Engineer, Burgess & Niple, Columbus, Ohio

THE CONCLUSIONS drawn by Mr. Baylis as to the benefits to be derived from surface washing of filter sand layers are well taken and may properly be considered in all places where trouble is encountered in the clogging of the sand beds by organic and other matters. But I believe his conclusions in favor of (1) 0.6 mm. as the most satisfactory size for sand grains, (2) the use of comparatively shallow sand layers and (3) the abandonment of the usual type of strainer system provided for the distribution of wash-water throughout the bottom of the filter should be looked upon with hesitation before their adoption in other plants.

Mr. Baylis seems to place too much stress upon the work accomplished at or near the surface of the sand filters. His suggested design goes back many years to the old rapid sand filters, particularly of the Warren type. The Warren filters had false bottoms covered by brass screens on which were placed 20 in. of coarse sand or crushed rock, without any coarse supporting material, such as is now commonly used to depths of from 14 in. to 18 in. The only material difference between Mr. Baylis' suggested design and the Warren type filter is the fact that agitation of the sand grains was secured in the Warren filter by mechanical rakes extending into the sand to a depth of about 12 in. whereas Mr. Baylis' design contemplates the use of surface agitation of the sand by water jets. The writer has investigated many old-type sand filters using mechanical rakes for agitation during washing of the sand and has yet to see one where trouble was encountered with mud balls or surface clogging of the sand when the agitators or rakes were properly used. In some instances, however, the quantity of wash-water was excessive due in part to the necessity for frequent washing.

More recent designs have done away with mechanical rakes, by using compressed air for agitation, and later by using high rates of application of wash-water without other agitation. Much trouble arises in filters with air agitation during washing due to surface clogging of the sand layers. Less frequently high-velocity wash causes trouble.

As to the work done by the upper sand layers, modern designs generally require the use of 30 in. of comparatively fine filter sand provided with a view to prevent sudden unloading of the filters, a condition of operation which was very common with the Warren type of filters. The shallow, coarse filter layers may unload suddenly without warning but this very seldom happens with the deeper, finer sand now commonly used. It would seem to be a step backward to use the shallow, coarse sand layers suggested by Mr. Baylis. Furthermore, the comparatively deep fine sand is very necessary in plants where difficulty is encountered in securing always a satisfactory treatment of the water before filtration. The fine sand permits much higher filter efficiency with poor preliminary treatment than can be obtained with coarse sand. The writer does not wish to be misunderstood as saying that a shallow, coarse filter may not be efficient at Baltimore but merely wishes to caution against its use at other places without a thorough and proper investigation of local conditions.

During the past two years the operators of the filter plant at Sharon, Pa., have been using the same principle to clean the surface layers of the sand as that suggested by Mr. Baylis, although applied in a different manner. At Sharon the chief engineer of the plant has provided a ¾-in. wrought-iron pipe about 8 ft. long connected to a hose carrying water under about 100 lb. pressure. The end of the pipe for a distance of 6 or 8 in. is perforated with ⅛-in. holes and the operators pass this through the surface of the sand at any spot where there seems to be inefficient washing of the surface of the sand. This plant contains eight units, each of 625,000-gal. daily capacity and the writer has frequently during the past two years inspected the sand beds and has always found the sand in perfect condition. Previous to the use of the jets, some difficulty was encountered, especially in the fall and spring, in securing satisfactory washing of the filters, even when the wash-water was applied at rates above a 24-in. rise per minute.

Devices for supplying extra washing of the surface of the sand are not expensive and may be applied readily to existing plants at small expense, but experience to date would not seem to warrant their use to the exclusion of the usual strainer system and high-velocity washing of filters now commonly employed. In small plants, gelatinous deposits on the sand grains have been eliminated by sprinkling hypochlorite of lime in solution over the surface of the sand beds which were kept out of service for at least 24 hours and then thoroughly washed. This treatment is practical for small plants and quite effective as an emergency measure, but would not be satisfactory for large plants.

* * *

Colloidal Theory Not Inconsistent with Baylis' Findings

By J. W. Ellms
Of Frazier-Ellms-Sheal Co., Consulting Engineers, Cleveland, Ohio

WITH THE very careful observations and descriptions of cracks and of the colloidal coating on the sand grains, observers will generally agree with Mr. Baylis. As to the causes for the phenomena, however, it is believed that not all will arrive at the same conclusions.

The nature of the colloidal coating on the sand grains certainly will vary with the character of the water being

treated. The properties of the organic portion of the colloid surrounding the sand particles must necessarily be modified by the nature of the organic matter from which it is formed. The inorganic gelatinous portion of the coating will, of course, vary with the mineral constituents of the water and with the coagulants used in its purification. In addition there are undoubtedly, as Mr. Baylis has pointed out, other suspended particles, both organic and inorganic, which have become embedded in the gelatinous coating. We have, in consequence, a colloid of complex composition whose characteristics are fixed by a number of factors, variable even for the same water at different periods of the year, and certainly for different waters from various sources.

The natural conclusion must be, therefore, that the colloidal coating consists of a mixture of suspensoids and emulsoids with impurities diffused throughout the mass. It requires no stretching of the imagination to conceive of the possible interaction of these general classes of colloids, and of the play of micro-forces, so ably discussed by Frank Hannan (*Journal* Am. W. W. Assoc.) in his paper on "Micro-Forces" between interfacial systems, which would be capable of producing surface cracking of sand filter beds quite apart from any settlement of the bed. Settlement probably does contribute toward the production of this phenomenon, but the writer cannot escape the conclusion that there are other forces at work which have fully as much, if not more, to do with it than settlement of the sand bed. Mr. Baylis' description of the elasticity of the surface coating of the bed, and of the effect of any sharp edge cutting through the surface in starting a crack, only confirms the writer's belief in forces inherent in the colloids themselves which play a large part in crack formation.

The author's remedy for removing the colloidal coating is certainly interesting, but his conclusion that so large an effective size of sand grain as 0.6 mm. is desirable, and that a very elementary strainer system is all that is required, is not so easy to understand. If the sand bed is to be floated in order that the small jets of water at high velocity may scour off the accumulated colloidal coating, then a strainer system that will uniformly distribute the wash-water and properly float the bed without blowing holes through it is a necessity. All of the hydraulic conditions required to produce a uniform upward flow without jet action must be maintained.

It is to be presumed that the studies made by Mr. Baylis were undertaken for the purpose of finding a method for maintaining the filter bed at its highest efficiency from the bacterial standpoint, and it is, therefore, to be regretted that the effects of the changes made in washing the bed on the bacterial efficiency of the filter are not included in his valuable investigation.

* * *

Jet Washing Is Not Satisfactory at St. Louis

By C. M. Daily

Engineer in Charge, Supply and Purifications Section, Water Department, St. Louis, Mo.

MR. BAYLIS has presented a very interesting paper on his experiments with filter sand handling soft water carrying large amounts of organic matter. His conclusions are based on the results obtained which may not be applicable to water having entirely different characteristics, such as the turbid water of the central and western states.

In 1916 we attempted to remove the gelatinous coating on the sand in the St. Louis filters by jets similar to those Mr. Baylis describes but the results were unsatisfactory; it required more violent action than it was possible to obtain with the jets using higher pressure and greater volume than were used in the Baltimore filter. I am inclined to believe that the coating of organic matter found in the Baltimore filters will not result from muddy waters carrying a large amount of inorganic matter in solution.

Mr. Baylis states that "aluminum hydroxide is certainly not essential." I am inclined to think that he should confine his conclusions to water having the Baltimore characteristics, for we have found a turbid influent can be immediately remedied by the addition of a small amount of aluminum sulphate to the influent water, or to the filter bed itself. When the St. Louis plant was first put in operation in May, 1915, no aluminum sulphate was used for several months, because the handling equipment was not ready. It was a rule, rather than an exception, to have a low turbidity of perhaps 4 or 5 p.p.m. in the effluent, but the addition of the aluminum sulphate to the influent water or to the bed itself in a short time would produce clear water. It is undoubtedly true that any gelatinous substance that will coat the grains or form a light porous blanket over the bed will produce a clear effluent.

Where the water contains a large amount of calcium carbonate the sand will become caked due to this mineral depositing on it, and if we attempted to wash our filters on a 14-in. vertical rise per minute, with jets agitating the top portion of the sand, I feel that we would be inviting caked sand beds—not from inorganic coating, but from deposits of mineral matter.

I am very much inclined to adhere to the underdrain system where a loss of head through the orifices will be very high compared to the loss in the gravel and sand, so that the slight caking of the sand will not materially decrease the amount of water passing through it, a condition which seems to me would occur with a false bottom where the loss of head lies chiefly in the sand and gravel.

During the past year, the St. Louis Water Division, at the suggestion of E. E. Wall, water commissioner, has made to date (Dec. 29) 51 experiments with eight filters. In seven of the filters the size and depth of the sand and gravel were kept constant; in the other filter the size and depth of the sand were varied. The results are erratic, as was expected, but by taking the mean result of several tests in each series and comparing the results of the eight filters for turbidity, bacterial count, length of run, etc., we find that the filter having the lowest bacterial count may not have the lowest turbidity and usually has a shorter run for a definite loss of head. However, the lowest bacterial count and the lowest turbidity were more often found in the same filter than either was found with the maximum run.

Briefly the tests covered a water temperature range of 35 to 81 deg. F., a sand depth of 12 to 26 in. and sizes of sand ranging from 0.17 to 2.0 mm. A ½-in. blanket of fine sand composed of grains varying from 0.17 mm. to 0.26 mm. in diameter on a bed of sand 11½ in. thick, graded from 0.26 to 2 mm., gave the shortest runs, and in some cases as low turbidity and bacterial count in the effluent as any of the other filters. The filter giving what appears to be the best results from a practical standpoint contained 24 in. of sand graded from 0.39 to 1 mm. "The best results" may be quite troublesome to decide. If a filter runs 48 hours and yields an average effluent with turbidity of 0.5 p.p.m. and a bacterial count of 15, is it as good as one working under the same conditions which runs 70 hours and gives an effluent with a turbidity of 0.45 p.p.m. and a bacterial count of 20? What weight should be given to the average bacterial count, the average turbidity and the length of run? Until such problems can be correctly solved the best grading of filter sand cannot be formulated.

I agree with Mr. Baylis that it is hard to find a good reason for a graded sand, but in some places the cost of producing a uniform size of sand may be prohibitive.

* * *

Recognition of Biological Activity Most Notable Factor

By W. Donaldson

Chemical Engineer with Fuller & McClintock, Consulting Engineers, New York City

PRIOR to Mr. Baylis' paper the relation of loss of head to the amount of sand shrinkage, the increased likelihood of shrinkage from the smaller size sand and the rôle of organic matter had been suggested although there was a lack of agreement as to definite values to be attached to these factors.

What Mr. Baylis has done is to apply laboratory methods and close observation to the underlying mechanism of filter behavior with the result of bringing to light heretofore unrecognized facts. For instance, we have not been accustomed to regard the mechanical filter as having biological activity as shown by the rapid growth of a bacterial slime on the sand grains and by the decrease in dissolved oxygen and increase in CO_2 content of the water passing

through the filter. Again the seasonal variation in the thickness of the organic film on the sand grains and its correlation with a tendency to form cracks and mud balls are important facts brought to light by this investigation. Mr. Baylis' conclusion as to the cause of cracks and mud balls appearing in the bed is supported by data which make their acceptance more reasonable than some of the theories advanced in recent years based on physico-chemical explanations.

Of particular interest is the observation regarding the desirability of a coarser sand size during summer than during winter months. The conclusion that 0.6 mm. sand is the desirable average size for the Baltimore conditions may call for some modification of views of those who have held to the idea of an invariably fine sand of 0.4 mm. or smaller.

While the facts as to the Montebello filters may be considered very thoroughly worked out, it is not wise to generalize too far on applicability of the conclusions to other localities where sand bed troubles are encountered. For instance, the incrustation and clogging of sand in the softening plants, such as McKeesport, Columbus, St. Louis, Grand Rapids and New Orleans, present somewhat different problems. The clogging of filter strainers and collection systems from whatever causes must be recognized as a fruitful source of sand trouble, such as mud patches and uneven beds, independently of the films on the sand grains.

Although the author lays the primary blame for the sand troubles at Montebello on the bacterial film which occurs on the sand grain he recognizes the possibility of other organisms than bacteria being a factor. The wisdom of this reservation is apparent from the known clogging effect in other localities from crenothrix, algæ and such minute animal forms as crustaceæ, bryozoa and fresh water hydroids. Grass roots, in fact any material of fibrous nature, tend to the formation of mud balls. Also it remains to be seen how much the bacterial slime on sand grains is a factor at those western plants where continually turbid water is handled.

While the remedy proposed at Baltimore of installing auxiliary wash jets above the sand seems a satisfactory method, other filter operators may reasonably urge that this method is not the only solution. There are well managed filtration plants where the sand beds are kept in satisfactory condition by the use of an auxiliary air-wash, a feature which in latter years has shown a tendency to disappear from filter installations, not because the air wash was not found effective but because of the general view that it was an additional complication which could be dispensed with without material disadvantage. It is worth noting that at some of the larger plants, such as Hackensack and Toledo, the air wash has been continued in the new filters added within the last few years. Regular scraping of the sand surface is another expedient which has been successfully used. Diligent use of hand screens at many of the smaller plants gives satisfactory results, while handling of the sand in and out of the filter by sand-jet equipment once a year or so serves to overcome the problem of keeping the sand in condition at other plants. Still another expedient occasionally used is the application of chlorine to the settled water instead of to the filtered water.

Whether or not the conclusions of Mr. Baylis be concurred in, his results certainly show what can be done by a painstaking study of the chemistry, biology and mechanics of the filter beds. Other water-works chemists would do well to apply the same methods of intensive laboratory study and observation to their own problems.

* * *

Suggests Manganese as Factor in Causing Sand Cracks

By John B. Hawley
Consulting Engineer, Fort Worth, Tex.

THE FILTRATION fraternity is under conspicuous obligations to Mr. Baylis for this research and report, even though some of his conclusions are rather startling. I spent a few hours at Montebello last July and together with John H. Gregory inspected Mr. Baylis' experimental work and records. Methods used were all that could be desired, and the derived data are undoubtedly dependable. It would therefore seem that his conclusions, as applied to the Montebello filters, at least, must be accepted. His logic on the formation of cracks and mud balls as resultant, in great measure, from the gelatinous coating of sand grains, is, in the light of his observations, apparently sound, but I am not so confident of his statement on optimum diameter of sand grain as 0.6 mm. As to uniformity coefficient, conventional practice has been rather lax in limits, but his suggestion of 1.0 as the ideal for the upper 16 or 18 in. seems questionable. In practice it is unattainable.

Analysis of the gelatinous coating is of commanding interest but I am wondering if the MnO_2 content bears any relation to the cracks. At Breckenridge, Tex., we had manganese troubles a plenty, and were able to trace the source. (*Engineering News-Record*, May 10, 1923, p. 834.)

By and large, I think the "top wash" idea excellent, that it will not only save wash-water, minimize cracks and mud balls, but probably will enable us to remodel completely if not indeed dispense with the conventional collector-and-wash systems on filter floors.

* * *

Manganese on Sand Causes Shrinkage in California Filter Beds

By W. F. Langelier
Associate Professor, Sanitary Engineering, University of California, Berkeley, Calif.

THE SAN PABLO Plant of the East Bay Water Co. at Berkeley, Calif., has offered an excellent opportunity to study the related phenomena of filter sand incrustation and shrinkage. This 12-m.g.d. rapid sand filtration plant was placed in operation three years ago. At the end of the first year's operation, the finer sand grains had become coated with a dark brown or black incrustation and evidences of shrinkage of the sand bed were apparent. During the past two years this condition has become intensified, but we believe that observations made during this period are of value in indicating the cause, and possibly the solution, of this perplexing problem.

An impounded reservoir which throughout a greater part of the year supports a heavy growth of microscopic organisms is the supply. In order to reduce the burden on the filters as much as possible, the water is usually drawn from the lower levels of the reservoir. Many of these organisms, however, are not excluded and some of them, particularly the water fleas, survive the coagulation and sedimentation basins and at times penetrate the filter sand in considerable numbers, thus placing a heavy load of organic matter on the filters, which is further increased by the development of certain filamentous organisms in the 3½-mile tunnel connecting the reservoir and plant. The development of these organisms is undoubtedly favored by the low oxygen content of the water from the lower levels of the reservoir.

Among these organisms, a large number give a strong manganese reaction and are presumably some form of Crenothrix. Although iron is absent the raw water contains from 0.05 to 0.50 p.p.m. of manganese and it is to the presence of this substance that we attach the greatest significance and attribute most of our filter and sand troubles. The writer is of the opinion that the character of the water is responsible for the incrustation and that the character of the sand is a factor only in the phenomenon which develops subsequent to its formation. Colloidal calcium carbonate, for example, will undoubtedly form an incrustation on any sand with which it is brought into contact. The incrustation at San Pablo is composed of hydrated manganese and aluminum oxides and organic matter, as indicated by the following percentages based on chemical analysis of a sample removed from the sand by prolonged and vigorous agitation in water: Loss on ignition, 60; alumina (Al_2O_3), 26; manganese dioxide (MnO_2), 11.5.

In 1914, the writer participated in an investigation of the occurrence and removal of manganese in several water supplies, which showed that small amounts of manganese in water, so slight as to escape notice, would in time cause almost complete stoppage of service pipes. It was also found that the manganese could be removed from the water by filtration through a layer of manganese dioxide.

When the moist incrusted sand is compressed in the hand the feel is like that produced by squeezing a handful of granular cork or rubber. The wet sand is also very plastic, so much so that a rod forced into the sand to the gravel layer will upon withdrawal leave a perfect impression. If the wash-water is then turned on a jet will be formed at this point.

Compression or settlement of the sand layer during a filter run has been measured several times during the past year, the method employed being similar to that used by Mr. Baylis. The settlement, during an ordinary filter run with a maximum loss of head of 8 ft., averages approximately 1½ in., but in some instances the settlement has been as great as 2 in. As the depth of the sand layer at this plant is 24 in. these values indicate a maximum shrinkage of 8.5 per cent. It should be noted that since the amount of incrustation diminishes very markedly with the depth, the shrinkage of the sand near the surface of the bed where the cracks are formed must be considerably greater than this figure. The proportion of incrustation to sand and the corresponding size of sand grains at various depths in the filter are given in the following table:

Depth Below Surface In.	Average Size of Sand Grain with Coating, Mm.	Per Cent Incrustation by Weight
0 to 5	0.67	18.8
8 to 12	0.90	7.5
12 to 18	1.60	3.5
18 to 24	2.20	1.5

The most serious difficulty resulting from sand incrustations of this type is the tendency toward the formation of cracks over the surface of the filter medium, such as has been described by Mr. Baylis. This plant has not been an exception, in fact we have observed filter cracking in a most aggravated form. In a few instances, cracks 2 to 4 in. deep and 1 in. wide at the top have formed a complete network over the entire surface of the filter. At other times we have noted deeper and wider cracks but fewer in number. These cracks have formed in spite of the most careful operation of the plant. Coagulation is good. The filters are rarely called upon to filter up to their rated capacity and the loss of head is never allowed to rise above 8 ft. More than usual care is exercised in admitting wash-water to the filters and during each wash the sand in the filters is thoroughly raked by hand. The gravel has not shifted and the distribution of wash-water by the underdrains appears to be uniform.

Our explanation of the crack formation is simply that the cracks are started by unequal settlement and that they grow in size due to unequal lateral pressures on the two sides of the fracture. The unequal settlement is due to vertical stratification of the coarse, slightly compressible sand and the more highly compressible finer sand. This vertical stratification in turn is due to the jetting of wash-water caused by the very plastic condition of the sand. Evidence of the correctness of this conclusion has been indicated by examination of the sand at the points of origin of the cracks, also by the fact that, if a filter is drained after washing and is then allowed to stand for a few hours, small cracks, obviously caused by settlement, are formed, always in the vicinity of coarse, relatively clean sand. Once formed, there will be a tendency toward a different loss of head within the opening of the crack and within the sand on either side, hence a lateral pressure of water against each face, which causes compacting of the plastic sand and enlargement of the crack.

If we assume that these explanations are correct, one obvious remedy would be the use of a fairly coarse sand of perfectly uniform size so that each grain would accumulate a minimum and at the same time a uniform depth of coating. This may not be entirely practicable, but the writer is of the opinion that, in general, much benefit may be derived from a more careful selection of filter sand, especially sand with the lowest uniformity coefficient.

At the San Pablo plant, plans are being made to refill some of the filters with sand of an effective size of 0.40 mm. and a uniformity coefficient of 1.3. Arrangements are also being made to install a blower to study the effectiveness of combined air and water wash. Other experiments are now in progress to determine the effectiveness of a roughing filter of fine gravel as a more permanent solution of the problem.

Checking Mr. Baylis, our observations also indicate a greater tendency to crack during the summer months, but we are inclined to believe that, at least at this plant, this increased tendency to crack is due to other causes, notably higher rates of filtration and greater loading of organic matter. Our water temperatures vary between a maximum of about 65 deg. F. in summer and a minimum of 48 deg. F. in winter. Although the water is chlorinated before filtration, evidence of a considerable bacterial population in the filters is indicated by an almost complete de-aeration of the water during its passage through the filters. There is no evidence of the liberation of any gases in the filters and we concur with Mr. Baylis that the oxygen is converted to carbon dioxide by bacterial agencies. Many determinations of dissolved oxygen made during the past two years indicate that whereas the applied water, which is aerated, is usually about 90 per cent saturated with dissolved oxygen, the effluent is rarely more than 30 per cent saturated; at times the effluent is devoid of dissolved oxygen. The removal of dissolved oxygen is equivalent to almost 2 cu.ft. of free oxygen gas per square foot of filter area per day.

The analytical determinations reported in this discussion are the work of Joseph Costa, a student in sanitary engineering at the University of California.

* * *

High Pressure Line for Top Washing Supply Suggested

By Dabney H. Maury
Consulting Engineer, Chicago, Ill.

MR. BAYLIS' deductions are founded on evidence which seems to justify them fully. With the possible exception of provisions for insuring an equal distribution of wash-water, practically all measures adopted in the past to prevent the formation of mud balls have apparently been aimed at the effect rather than at the cause.

Whether one agrees or disagrees with the theory presented in this article, the fact that this theory led to the adoption of subsurface jet washing, and a consequent improvement in the operation of the filter beds, should be of the utmost importance to engineers interested in the design of such units.

Since the expense of providing a high pressure line for the installation of a grid work similar to that suggested by Mr. Baylis is not large, it would seem that future ideas might well incorporate this idea. With such a line in place and with a suitable connection to each filter unit, the time and expense involved in trying out various types of grid would be small.

* * *

Larger Underdrain Openings Possible If Top Jets Keep Sand Clean

By Leonard Metcalf
Of Metcalf & Eddy, Consulting Engineers, Boston, Mass.

MR. BAYLIS' conclusion that an excessive coating of the sand grains by a biological film was responsible in a large measure for the troubles encountered appears logical. The results of his tests appear to demonstrate that this excessive coating under the conditions there prevailing can be prevented by auxiliary washing from jets in a pipe system placed just below the normal level of the sand.

It has frequently been thought that the character of the underdrainage system in rapid sand filters has been partly responsible for the cracking of the sand bed away from the side walls and for clogging, due to improper washing of the sand along the wall. It is interesting to note that the underdrain systems at the Baltimore and Cincinnati plants are somewhat similar although the Cincinnati design would appear to be, from a theoretical point of view, somewhat more efficient in distributing wash-water along the walls of the filter tank than that at Baltimore.

In several plants provided with perforated-pipe strainer systems with the first pipe lateral placed near the wall,

there seems to have been but little trouble from the formation of mud balls along the walls or from serious cracking.

Tests of various types of underdrain systems have shown that a satisfactory distribution of the wash-water can be readily obtained with a relatively large area of waterways so long as the sand in the filter is clean. As soon, however, as the sand voids become clogged unequally in different parts of the filter, there is danger of the wash-water breaking through in the less clogged portions of the filter, with the result that the other portions are inadequately washed.

Experiments with a type of underdrain similar to that employed at the trickling filters of the Fitchburg (Mass.) sewage-works demonstrated the danger of wash-water breaking up through a filter sand after the sand had been used for a time. This underdrain system at Fitchburg (see *Engineering News*, June 5, 1913, p. 1178) consisted of 1x3-in. concrete blocks set on a corrugated floor forming parallel slots thereby providing a large percentage of draining area. The plan to build a somewhat similar floor at the Baltimore water filters using 2x8-in. dressed pine planks placed 1 in. apart over a shallow compartment is of interest. If the proposed system of horizontal jets can keep the sand clean enough to prevent unequal resistance to the rising flow of wash-water, such an underdrain system may prove successful.

The two years' successful operation of the test filter, as reported at Baltimore, indicated that jet washing is effective under the local conditions. But broader investigation is needed before final conclusions can be drawn and general adoption of this method of filter washing would be safe. The Baltimore results are suggestive, however, and worthy of careful study and thought.

The proposed use of sand very uniform in size, about 0.6 mm. in diameter, is a departure from the more or less generally established practice of specifying sand of between 0.25 and 0.35 mm. A few plants such as that at Detroit have used sand having larger grains in order to secure high filtration rates. As a general rule, the grains of filter sand have been of varying sizes within certain limits and uniformity of size has been merely nominal. There does seem to be a recent tendency toward the use of larger grains. It has generally been thought, however, that the bad effects resulting from the cracking of the sand might be avoided to some extent by increasing the depth of the sand bed. It will be of interest to follow the results of operation of the new Baltimore filters to see if the benefits expected from the use of uniform sand of large diameter on the surface of filters are secured, particularly in winter filtration.

Mr. Baylis does not indicate the manner in which chlorine was used for the prevention of the gelatinous organic growths upon the sand grains. The fact that the use of chlorine was for a period of only two weeks indicates that the trial was not very extensive. It would appear possible to destroy the growths by the use of a heavily chlorinated wash-water or by allowing the sand bed to remain out of service a short time and filled with a somewhat less heavily chlorinated water.

Having once secured the destruction of the growths, prechlorination of the water would tend to prevent their excessive occurrence. For this purpose, the amount of chlorine required would probably not be sufficient to impart taste and odors to the filtered water.

Inasmuch as algae may also be a factor in the formation of the coating of the sand, the use of copper sulphate, either alone or in conjunction with chlorination might be worth trial.

Additional studies of this question as to the best means for maintaining filter sand in proper condition are highly desirable. The results at Baltimore, for the conditions there prevailing, appear conclusive, but the character of the raw water to be treated undoubtedly has an important bearing upon the results obtained and similar results with other types of raw waters might not be so readily secured. Notwithstanding the favorable results obtained in the Baltimore tests, it would seem to be wise to obtain considerable corroborative evidence with different raw waters before general acceptance of the practicability of departing from the present practice of limiting the area of openings of the underdrain system.

Proper Flocculation and Washing Will Eliminate Filter Troubles

By F. H. Waring

Principal Assistant Engineer, Ohio State Department of Health

THE THOUGHT occurs to the writer that possibly control of the amount of organic matter coming to the filter in the influent water by judicious coagulation might serve to minimize the film formation to such an extent that it would not be the source of filter sand trouble and yet be of sufficient amount to allow the filters to function in excellent manner. Because Ohio filter plants are forced to coagulate rather heavily, it may be that the amount of film-forming material reaching the sand grains is therefore much less than was found to be the Baltimore experience. Raw waters in this state are badly polluted for the most part, and since it is the practice to attempt to get filter effluents meeting Treasury Department standards, coagulation must be maintained at a high degree of efficiency.

Efforts to minimize the tendency toward side crack formation by the construction of filters with battered walls has not proved successful in this state. The experience at Elyria during the past year, and reported to the Ohio Conference on Water Purification at its third annual meeting in Columbus, Nov. 21, 1923, indicates that clogging of the sand bed takes place around the side walls in more pronounced degree in the filters with the battered walls, principally because the effectiveness of the filter washing is reduced in this zone.

It is believed that the main conclusion of Mr. Baylis' studies is quite sound; namely, filter troubles are the direct result of faulty filter washing. It is significant that the Baltimore experiments show that jet washing of the sand is a distinct advantage for those plants experiencing repeated filter sand troubles. The writer is not convinced, however, that these troubles could not be prevented, provided that uniformly well distributed wash-water at an average rate of 24 in. vertical rise per minute can be properly applied. In several plants in this state, however, filter sand troubles have occurred at various times, but in each instance the reason has been found to be poor coagulation of the water or negligence in filter attendance during washing or faults in the wash-water distributing system in the filter bottom. In the past year the experiences at Ironton (Wheeler filter bottom) and East Liverpool (Pittsburgh umbrella strainer system) have shown the characteristic troubles of clogged sand, mud balls and surface cracks resulting from poor filter washing. Examination of the filter bottoms in the case of East Liverpool showed plugging of the orifices, especially around the edges of the filter by foreign matter that probably was left in the pipes at the time of construction of the plant. At Ironton investigation revealed that the night operator was greatly under-washing the filters on his shift, causing the sand beds to become gradually fouled. At both of these plants proper corrections were made during the summer and an excellent condition of the sand filters has since prevailed.

The installation of a separate grid for jet washing of the sand may effect economies in filter construction if a manifold or strainer system may be omitted as suggested by Mr. Baylis, and certainly this jet action will prove beneficial in operating. The writer does not believe that carbonate incrustation of sand grains in water softening plants will be prevented by jet washing, although the formation of the lime coating may be retarded somewhat.

The conclusion regarding the importance of size of sand and the grading of the sand in the filter, the writer subscribes to heartily. However, in Ohio we have favored 0.4 mm. size, a much finer sand than that of 0.6 mm. recommended for Baltimore. Preference is given in this state to rather uniform sand for the filtering medium of at least 24 in. depth and supported upon a 4-in. layer of coarser material such as torpedo sand. Examinations of sand from existing filters have been conducted upon samples taken at about a 6-in. depth because of the belief that the filtering medium does really extend beneath the surface to considerable depth. As already stated raw waters in Ohio are rather heavily polluted, as is evidenced by the fact that

the Ohio River at the Ironton plant during August, 1923, averaged 22,000 B. Coli per 100 cc. It has been necessary, then, for each step in the water purification process to be operated at a maximum degree of efficiency and most especially that of filtration. It is the writer's opinion that the most important factor in obtaining a high degree of filtration efficiency is the proper preparation of the water for filtration. A limited amount of well-formed floc in the influent water to the filters is essential. Secondly, the size of the sand must be fine enough and of uniformity enough to intersept and retain suspended flocculated material as well as to furnish the medium for proper film development.

* * *

Author Answers Points in Discussion

By John R. Baylis

IT WAS not intended that the conclusions set forth in the study of filter beds at Baltimore should be applied elsewhere without first checking up on local conditions. The fact that a vast number of filter beds throughout the United States form clogged places forces us to admit that we have a problem. Observations at other places having variable characters of water leads to the belief that alkalinity, turbidity and properly coagulated water are not the controlling factors, though they may have some influence. Evidence seems to prove conclusively that no rate of wash that may be applied under the beds will prevent clogging in many plants. An additional force is necessary to maintain such filter beds in good order, whether it be in the form of air, rakes, water jets or other means. It is believed that water jets will prove the more economical in many instances. Any device that merely corrects a bad condition, only to let the beds become bad again before correcting, is a makeshift that should not be tolerated. Whatever be the force necessary to keep beds in good condition, it should be applied. Attention to a satisfactory washing adjunct is almost as essential as it is to apply the necessary chemicals for proper treatment.

The statement that the top 16 to 18 in. of sand should be of uniform size was not intended to imply that this should be the total depth of sand in the bad; 6 to 10 in. of fairly coarse sand from 1.5 to 2.0 mm. below the filtering sand is very desirable. The coarse sand will aid in breaking up clogged masses that might escape the surface wash. The purpose of surface wash is not to break up clogged masses that have settled to the gravel layer, but to prevent them from forming. It is probably cheaper to break up the clogged places already formed by other means. Later experiments with chlorine tend to confirm the fact that it cannot be relied upon to prevent clogging under our conditions, although it probably offers some aid.

The idea of omitting the underdrains is Mr. Armstrong's, and full credit should go to him. It might be interesting to note that two years' operation of such a filter in our plant has shown that its condition is as good as that of the other filters.

The burden of proof that colloidal adsorption is responsible for shrinkage rests with its advocates. The pulling away of the sand from any vertical surface occurred only when filtering and when there was settlement.

It is not expected that there will be general agreement on sand sizes. Sand having an effective size of 0.6 mm. will filter properly coagulated water to a colloidal turbidity of 0.2 p.p.m., and a floc turbidity of 0.02 p.p.m., which is the desired standard for well operated plants. Unless there is bacterial action taking place in the filter beds, the bacterial removal is largely in proportion to the colloidal turbidity of the filter effluent. If the larger size offers aid in preventing cracks, it is the better size to use.

Bill Restricts Use of Wooden Passenger Cars

Use of wooden passenger cars between or in front of a steel or a steel-underframe car is prohibited in a bill which has been reported favorably by the Senate Committee on Interstate Commerce. Penalties are provided for violations of the proposed law. The legislation is based on an urgent recommendation from the Interstate Commerce Commission.

Towers of First Suspension Bridge Over Hudson River Completed

Erection of 350-Ft. Steel Towers for Highway Bridge Accomplished—Approaches and Anchorage Tunnels Under Way

DURING February the erection of the towers for the suspension bridge across the Hudson River at the lower edge of the Highlands, which is being built for the Bear Mountain-Hudson River Bridge Corporation, was completed, and riveting is now nearly completed. Work on the cables will begin this spring, and it is hoped that erection may be completed by the end of the year.

Erection of the steel towers was done by methods and equipment much like those used some years ago on the Manhattan bridge across the East River at New York. A creeper traveler carrying a stiffleg derrick of 50 tons capacity was erected on the river side of the tower, and as the successive sections of the main columns were set the creeper was pulled up by a special hoisting engine to a new position from which the next sections of the tower could be set. Each post consisted of three pieces above the bottom section, which consisted of seven pieces. The heaviest erection piece was 55 ft. long and weighed 50 tons. The posts of these towers are battered inward toward the top; the suspension and fastenings of the traveler were therefore designed to suit the different widths between posts at the successive settings.

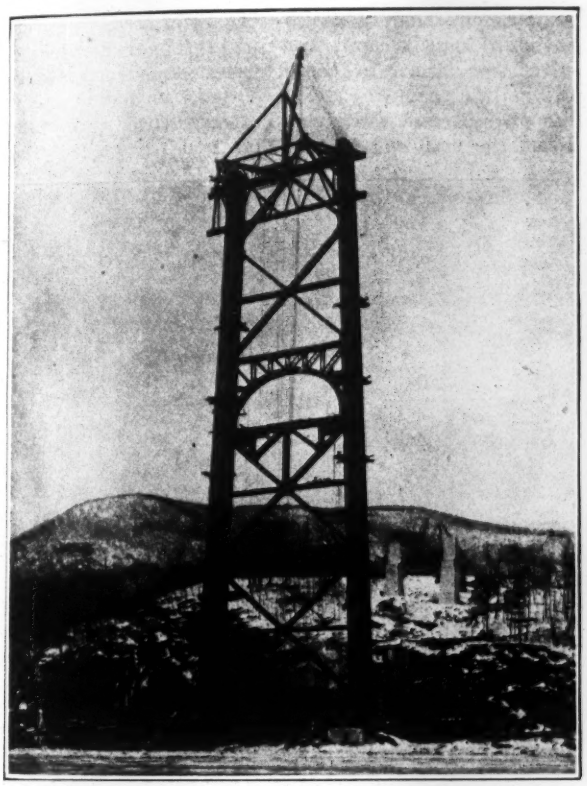
For the cable erection a foot bridge or working platform will be erected just under the two main cables. The girders for anchoring the foot-bridge cables are now being placed in the anchorage pits.

It is only two years since the conception of the project for the bridge, although the first charter for a bridge at this site was obtained in 1868 and many attempts to undertake construction were made subsequently. The present charter was obtained less than two years ago; after securing permits and completing the financial arrangements, a contract for construction was signed on March 24, 1923, and work was immediately begun.

The bridge will be a suspension bridge with straight (unloaded) backstays, of 1,632-ft. main span and with a clearance at high tide of 155 ft. It is to carry a reinforced-concrete roadway 38 ft. wide and two 5-ft. sidewalks. The west approach consists of two 50-ft. spans, one 100-ft. span, and one 220-ft. span, while the east approach consists of a single 220-ft. span. The main towers are 350 ft. high and rest on concrete piers carried on rock near water level. The two main cables will be 18 in. in diameter each. The anchor pits are inclined tunnels, those on the west bank about 110 ft. deep and those on the east bank about 90 ft. deep. The cast-steel bases to which the anchorage eyebars will be fastened are now being set in these tunnels. The cables carrying the suspended structure will be woven in place and will consist each of 7,452 parallel wires of 0.192 in. diameter. The stiffening trusses will be 30 ft. deep and spaced 55 ft. apart; they will be placed below the roadway, so that a clear view up and down the river will be obtained from the floor of the bridge. A horizontal truss under the bottom chord will act as wind-bracing. The transverse struts of this truss extend outside the chord and the suspender ropes from the cables are connected to them.

A large amount of highway work is required in constructing approaches to the bridge. On the east side a road is being built about 3 miles long from the end of the bridge to a connection with the present main road at a point near the state military camp at Peekskill. This is very difficult work, being side-hill construction through granite and for a long distance being immediately over the main-line tracks of the New York Central R.R. The west approach road will be only about 800 ft. long extending to the Henry Hudson Highway.

E. Roland Harriman is president of the bridge company and Wilson Fitch Smith is chief engineer. Howard C. Baird, consulting engineer, is responsible for the design of the bridge. J. V. W. Reynders is in charge of construction for the contractors, the Terry & Tench Co., Inc., who obtained the charter and have the contract for the whole work.



WEST (BEAR MOUNTAIN) TOWER AND EAST (ANTHONY'S NOSE) TOWER OF HIGHWAY BRIDGE ACROSS THE HUDSON

New Type of Fishway

A possible means of overcoming the objection of the fish industry on the Pacific Coast to the construction of dams on such streams as the Columbia, and the Sacramento and the Klamath Rivers and the rivers on the west coast of Alaska, is expected to be found in a type of fishway recently developed in California. Heretofore the Bureau of Fisheries has taken the position that fish will not cross a dam over 30 ft. in height regardless of what may be provided to facilitate their passage, but the recent experiments with a fishway providing a series of resting pools has demonstrated that fish will climb to this or greater heights.

Defect in Illinois Drainage Law

THE 1923 Illinois legislature amended the Drainage Act to provide that no bonds could be issued without submitting the bond issue to a vote of the District and that the rate of taxation for all purposes, exclusive of bonds and interest, should not exceed 0.66 per cent. Prior to the amendment the rate for all purposes exclusive of bonds and interest was 1.33 per cent, or in other words the rate was reduced 50 per cent. In the extension of 1923 taxes for the East Side Levee and Sanitary District, East St. Louis, the county clerk of St. Clair county felt that he must abide by this amendment and refused to extend a rate more than 0.66 per cent.

Attorneys for the District contended that the amendment was not legally passed in the legislature and in a mandamus proceeding in the Circuit Court to compel the county clerk to extend the taxes on the law prior to its purported amendment in 1923, the Circuit Court held that the act had not legally passed. Taxes were therefore extended by the county clerk based on the law in effect in 1923. The basis of the court's decision was that the Senate, in receding from an amendment in which the House had refused to concur, had voted without a legal majority being present.

While the law in question is general in its terms, the East Side District is the only one now operating under its provisions. The principal differences between this law and the Levee Act are: (1) It contains a provision allowing the organization of districts including territory in more than one county; (2) the manner of taxation is changed from a benefits assessment on property to a general tax on all classes of property.

C. & N. W. Ry. Depresses Busy Main Line at Milwaukee

Grade Crossing Elimination Improves Operating Conditions—New Four-Track Line—One Running Track Maintained During Work—Three Types of Monolithic and Precast Concrete Walls

IN A COMBINATION of track depression and elevation on the Milwaukee-Madison division of the Chicago & Northwestern Ry. in the city of Milwaukee, Wis., for the purpose of eliminating street crossings at grade, the railway company has been able to improve considerably both the profile and the operating conditions on this part of the line.

This improvement work was complicated by the necessity of temporarily operating heavy traffic over a single track through the work, this track being shifted from side to side of the 100-ft. right-of-way as the work progressed. Numerous industry connections also had to be maintained. Eight street bridges and three railway bridges over streets take the places of eleven grade crossings. Other features were three different types of concrete retaining walls and the extensive use of machinery to minimize the labor difficulty. The work included 450,000 cu.yd. of excavation and 28,000 cu.yd. of concrete. Four tracks will be laid at the new grade. Fig. 1 is a view of a portion of the work, showing one of the industry connections. A plan and profile are given in Fig. 2.

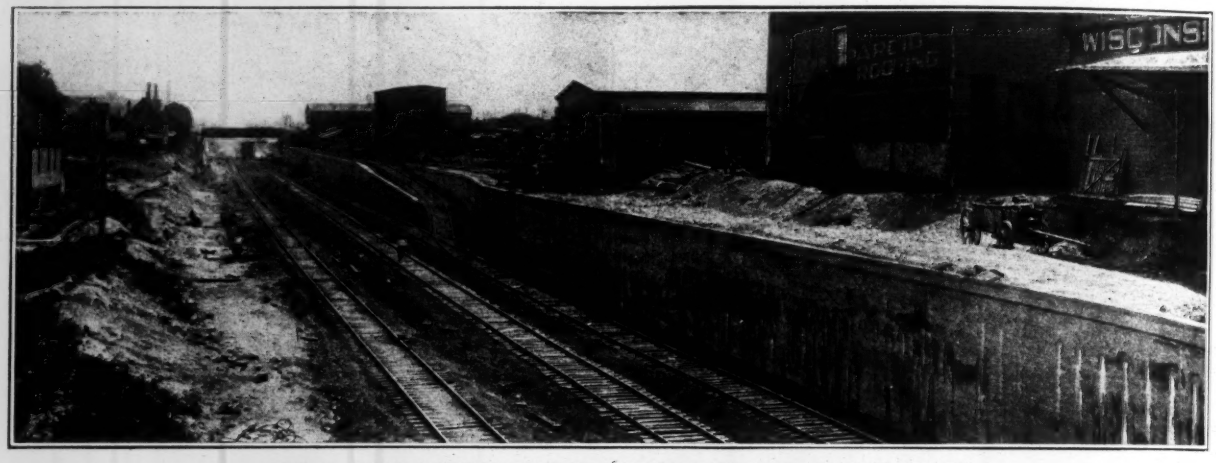


FIG. 1—TRACK DEPRESSION AT MILWAUKEE, WIS.; C. & N. W. RY.
Four tracks to be laid in cut. Inclined industry connection at right.

The Milwaukee end of the Madison division, passing through Layton Park in the southwest part of the city, traverses an industrial section, and has no less than twenty-three industry connections in a distance of three miles. The line extends into the city, but with the St. Francis cutoff it forms part of a belt line by which through traffic is kept out of the city terminals, this cutoff connecting with the second or inland double-track line of the Chicago & Northwestern Ry. between Chicago and Milwaukee. Since the Madison division is a part of the main freight route between Chicago and the Northwest it carries heavy traffic and during 1923 this freight traffic was exceptionally heavy, averaging about a hundred trains daily in both directions. As most of this traffic came during working hours it added materially to the difficulties of carrying on the work and handling the traffic. Furthermore, with the Mitchell freight yard at the west end of the improvement there are numerous switching movements between this yard and the city local yards, in addition to the frequent train service.

Under these conditions, combined with the growth of the Layton Park district, there has been for some years a demand for separation of street and railway grades. The city petitioned the Wisconsin State Railroad Commission to require the railway to carry out such an improvement, and in 1917 an order to this effect was issued by the commission and accepted by the railway company. The World War put a stop to the project, and work was not commenced until 1922. From the map and profile, Fig. 2, it will be seen that an undulating grade line with adverse grades against the heavier eastbound trains (3,600 tons trainload rating) is replaced by a continually descending grade eastward, except for a short rise at the east end to connect with the St. Francis cutoff and keep above First Ave.

Beginning at the west end there is a fill 0.86-mile in length to take out the present sag in grade lines through the Mitchell yard. This fill of about 100,000 cu.yd. has a maximum height of 13 ft. Then comes the 2-mile stretch of track depression in a cut having a maximum depth of 20 ft. For the greater part this cut is lined with retaining walls, but at certain points where the adjacent property is not built up an earth slope is left for the present.

Beyond this is 0.45 mile of track elevation on the main line into Milwaukee, with a maximum fill of 7 ft.; also 0.25 mile of track depression on the St. Francis cutoff, with a maximum cut of 8 ft. Formerly, there were maximum grades of 1 per cent in both directions, but the new profile gives a maximum of 0.7 per cent against westbound traffic and 0.5 per cent against the heavier loads of eastbound traffic. A long curve of 2 deg. carries the line around Forest Home Cemetery and the connection with the St. Francis cutoff is made by a curve of 7 deg.

Earthwork—Excavation amounted to 450,000 cu.yd.,

of which 420,000 yd. was in the 2-mile cut between First Ave. and Forest Home Ave. The material consisted largely of blue clay, which became very stiff and hard at the bottom of the cut, but there was some sand and gravel. Very little water was encountered, and where a strong flow occurred it was diverted into the channel of the Kinnikinnick River and into a city sewer which passes under the railroad. This large cut was handled with a steam shovel having a 3½-yd. bucket and loading air-operated standard-gage dump-cars. The cars were of nominal 12-yd. capacity, but sideboards were added to increase the capacity to about 16 yd. Except for the 100,000-yd. fill at the west end the material was used to fill low waste land at the Chase yard and engine terminal near the east end of the work. A compressed-air spreader-car operated by a separate locomotive was employed to level the material after being dumped from the cars. Construction trains of ten cars were handled by locomotives and crews furnished by the railway.

Two tracks were laid throughout the work, one of these being for regular traffic and the other for the contractors' trains, the regular traffic and switching movements being too heavy to permit handling the dump-car trains on the running track. The tracks were shifted from time to time, as the work progressed, and regular traffic was handled sometimes on one side and sometimes on the other, to keep clear of construction work. All movements of regular traffic and dump-car trains were controlled by two operators, one at each end of the work, in cabins provided with telephones to the dispatcher's office in Milwaukee. Hand flag signals were used to govern train movements within the working limits.

For the main cut, after completion of the south retaining wall, four shovel cuts were made, as shown in Fig. 4. In this excavation work, the steam shovel first made an 8-ft. through cut along the north side, in which a running track and a loading track were laid. The second cut, 30 ft. wide and 16 ft. deep or more, was carried down to subgrade, the excavated material being loaded on the upper track. Two permanent

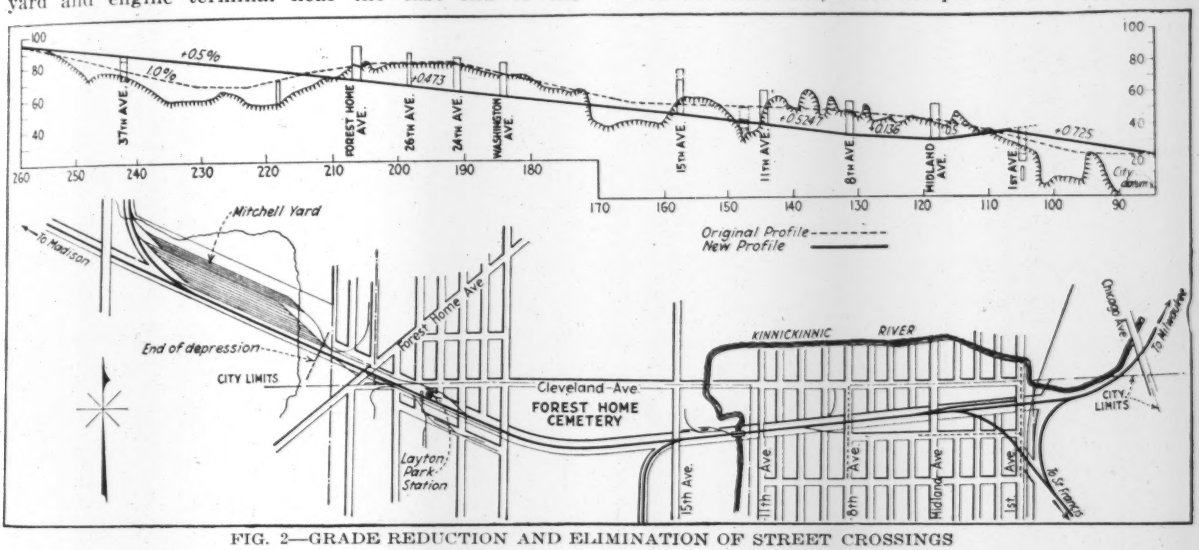


FIG. 2—GRADE REDUCTION AND ELIMINATION OF STREET CROSSINGS

An unusual combination of machine excavation was employed at the west end of the work, where brick buildings adjacent to the south side of the right-of-way made it necessary to build the retaining wall in trench before taking out the cut with the steam shovel. The trench was excavated to a depth of about 16 ft. with a dragline excavator handling a ¾-yd. bucket. Then the plank sheeting was driven and braced and the trench was finished to grade by a ¾-yd. clamshell bucket handled by a small revolving steam shovel. In this way very little hand labor was required in the trench. Compressed-air chisels or spades were used in dressing the lower part to shape in the stiff blue clay. This trench, with the wall and bracing, is shown in Fig. 3.

Another unusual feature of this trench work is that the struts and rear sheeting were left in place and concreted into the wall, on account of heavy pressure of buildings behind the wall. Thus the side of the trench is permanently braced against the wall, instead of relying upon the looser material of the backfill. By the time the timbers have reached their limit of life the backfill between the wall and the side of the trench will have become sufficiently compacted to resist the ultimate transfer of pressure from the adjacent buildings.

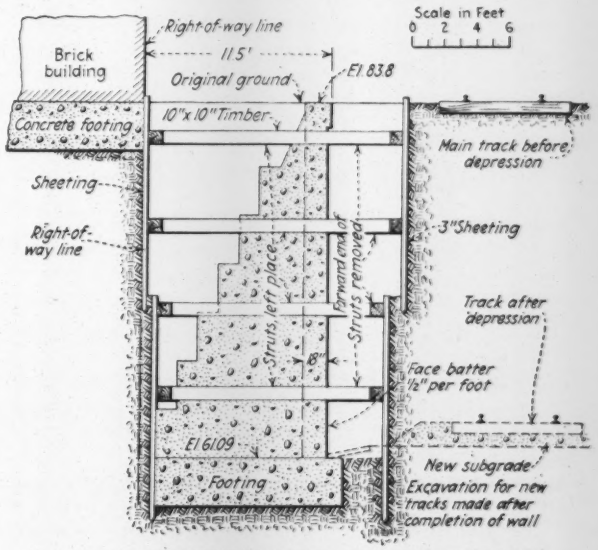


FIG. 3—RETAINING WALL BUILT IN TRENCH

tracks were laid at the low level immediately following the excavation. The third and finishing cut on the north side then enabled the smaller retaining wall to be built. The two permanent tracks laid at subgrade, following the large cut, were used as a temporary running track and a loading track for the final cut. The fourth cut completed the excavation to the wall along the south side, giving a clear width of 65 ft. between the walls.

Bridges and Subways—All structures as well as the cuts are being built for a four-track system with tracks spaced 14 ft. c. to c. Bridges carrying streets over the tracks are mainly through plate girder spans of 60 ft., no intermediate supports being placed. The floors are of transverse I-beams with concrete filled between and over them and carrying either brick or asphalt pavements. The girders will be encased with gunite as a protection against blast and smoke from the engines. Two subways carrying First Ave. under the main line and the cutoff have through plate girder spans for the railway. Similar structures are provided at 37th Ave. and across the Kinnickinnic River, but the latter has an open deck.

Industry Tracks—Maintaining the connections with industry tracks and handling the necessary switching movements for the industries along the line complicated the work materially. In two or three cases it was impracticable to maintain these connections and the industries had to provide for motor truck or a similar service from team tracks in the neighborhood. In most cases, the industry track is run up behind the retaining wall of the cut to ground level on a grade of about 3½ per cent (see Fig. 1), using No. 7 frogs and 15-ft. switch rails in the turnouts. The railway company pays for all the work within its right-of-way, but the industry has to pay the railway the cost of the work outside of that line. This apportionment of costs was made by the railroad commission of Wisconsin.

Gravity Retaining Wall—For about 2,000 ft. along the south side of the cut and in the deeper part where adjacent buildings necessitate rigid support, the retaining walls are of gravity section and monolithic construction, ranging up to 24 ft. in height. The typical section is shown in Fig. 3. A 1:3:5 concrete mix

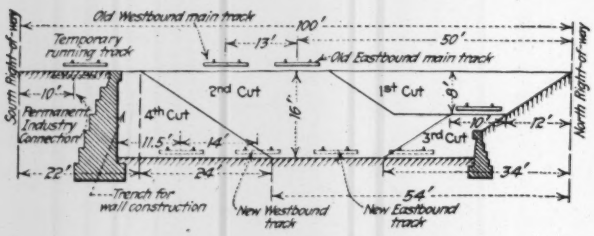


FIG. 4—EXCAVATION OF MAIN CUT

was used, with gravel aggregate of 2-in. maximum size. Wood forms were used throughout. No waterproofing medium was added to the mix or applied to the back of the wall, reliance being placed on the use of a dense concrete. Weep holes were provided near the bottom at some points where water was encountered.

Expansion joints, placed at intervals of 75 ft., are of the tongue-and-groove type and packed with tarred felt. In view of the length of the work and the number of bridge abutments, about half a dozen concrete mixers were distributed at various points. During the winter of 1922-23 this wall construction was carried on continuously after the main steam-shovel cut had been made. Frost aided in holding up the banks until the wall was completed, although in some cases it was necessary to provide blocking and shoring to support buildings adjacent to the right-of-way. For this winter concreting the aggregate was heated before mixing and the forms were covered with hay.

Pressure due to heavy buildings along the right-of-way made it desirable to build most of this retaining wall in trench in advance of the steam shovel work, and also to provide permanent bracing for the land or outer side of the trench. This involved difficulty since

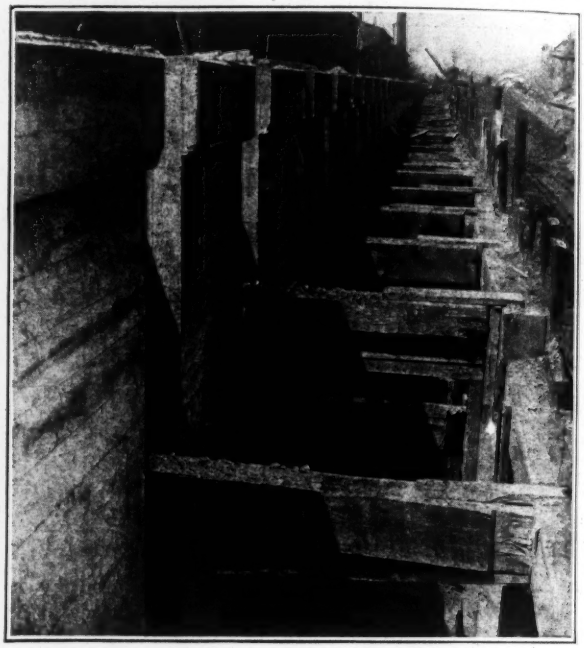


FIG. 5—RETAINING WALL RECESSED FOR PILASTERS

in some places the trench had to be more than 30 ft. deep. The method of excavating the trench and leaving the struts in place has been described above (see Fig. 3). No foundation piles were required.

After the footing had been placed, the wall forms were erected and were built around the trench struts or braces so that these were concreted into the wall. At each line of struts, 8 ft. apart, a vertical recess 18 in. deep was left in the face of the wall, the sides of the recess flaring apart toward the back so as to provide wedge anchorage for the concrete filling to be placed later. In order to give a good appearance in the finished work, this filled space represents pilasters on the face of the wall. After the concrete of the wall had set, the front part of each strut, projecting through the wall, was cut off at the back of the recess. A form with pilaster reveal was then placed against the face of the wall and the recess filled with concrete, the filling or false pilasters being held permanently in place by the wedge shape of the recess. Fig. 3 shows the wall, trench and bracing, and Fig. 5 is a view of the wall with recesses not yet filled.

Concrete Block Walls—Two types of retaining walls of precast unit construction were employed on this work, one being a block wall and the other a crib wall.

Both of these walls, shown in Fig. 6, were specially designed by the railway engineers.

For the block wall, a concrete footing was poured, having a 6-in. longitudinal shoulder or toe against which the first course of blocks was placed, as shown in the section, Fig. 7. These blocks were 8 ft. long, 2 ft. high and of varying width, their weight ranging from 4,000 lb. to 11,000 lb. The courses are locked together by a 6-in. longitudinal rib or shoulder, but the ends have plain mortar joints, with no interlocking. In this construction the offsets are on the face and the back of the wall is vertical. These walls are built to a maximum height of 11 ft. 6 in. The blocks were delivered on flat cars and set in place by a railway derrick car. Before setting a block a seal coat of asphalt was mopped on the back and on the top of the course below to exclude seepage water, no motar being used in the horizontal joints.

This type of wall was designed by J. S. Pole, engineer of track elevation, as being cheaper and more easy of construction than a monolithic wall of height up to 12 ft. The blocks are made by railway forces, being cast on a platform built originally for the construction of precast slabs for bridge decks. This platform is covered and heated so that work can be carried on in cold weather. Details of the forms are shown in Fig. 7, and each form is used many times. There is said to be a marked saving over built-in-place walls.

Concrete Crib Wall—At the west end of the work, where the grade is elevated and the country is not built up, concrete cribbing is used to retain the slope of the fill, as shown in Figs. 6 and 8. This cribbing is composed of reinforced-concrete headers and stretchers of uniform shape and size, 8x8 in. in section and 6½ ft. long, weighing about 450 lb. each. These members do not interlock in any way, but have three 1¾-in. cored holes through which vertical 1-in. round dowel pins are inserted as the cribbing is built up, these pins being grouted in place to make rigid construction.

This cribbing is built up as the fill is made, so that the lower portions of the compartments are filled and anchored before the upper parts are built. The wall has a face batter of 1½ in 12 and reaches a maximum height of about 12 ft. An unusual feature for a retaining wall of this kind is the use of a concrete footing and toe wall as a base, in order to prevent settlement of the cribbing. This type of wall is considered to have advantages in convenience and economy wherever it can be used, particularly so in this instance where soil conditions were unstable for a heavy mass or gravity wall.

The precast members of both these types of wall were made at the railway yards in Chicago, except that a small proportion of the cribbing was made on the work by the contractor. A mix of 1:2:4, with 2-in. stone aggregate, was used in both cases. For the blocks, a mortar facing was placed in the forms to give a smooth finish like stone, but no attempt was made to obtain a smooth surface for the crib members.

In making these crib members on the work at Mil-

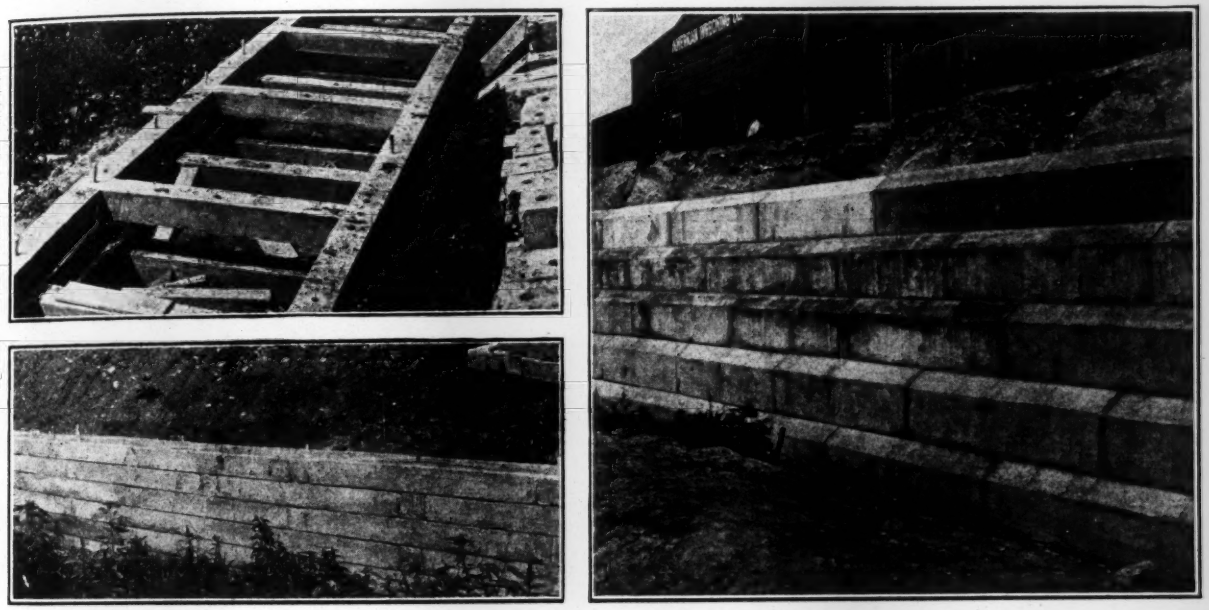


FIG. 6—PRECAST BLOCK AND CRIB RETAINING WALLS
At left: front and top view of concrete crib wall. At right: wall of 8-ft. concrete blocks.

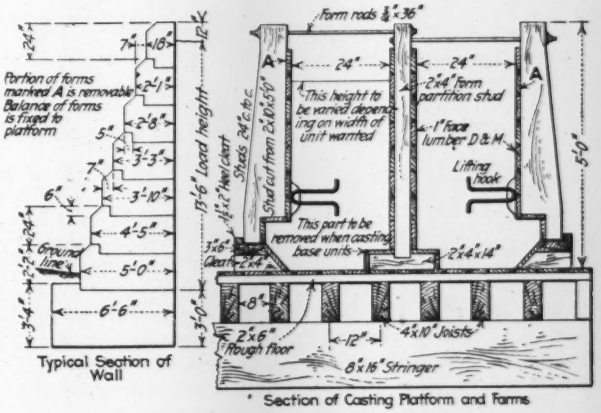


FIG. 7—CONCRETE BLOCK WALL AND FORMS FOR BLOCKS

waukee, wood forms were used for twenty members each. The form, laid on a wood platform, had transverse, 1-in. separating planks spaced to form compartments alternately 8 in. and 6 in. wide. Concrete was poured first into the 8 in. portions and after it had set for 24 hours the planks were removed, leaving 8-in. open spaces. Strips of roofing were laid against the members already cast and then concrete was poured into the open spaces. After 48 hours more the forms were removed and the concrete members were loaded on cars and delivered at the wall. In each piece three 1½-in. holes were cored by 8-in. lengths of pipe, the pipe being knocked out after the forms were removed. For handling the concrete cribbing, the derrick cable had attached to it a scissors tongs with the lower ends made to fit into the cored holes. When the weight came on the cable these ends were forced apart against the sides of the hole.

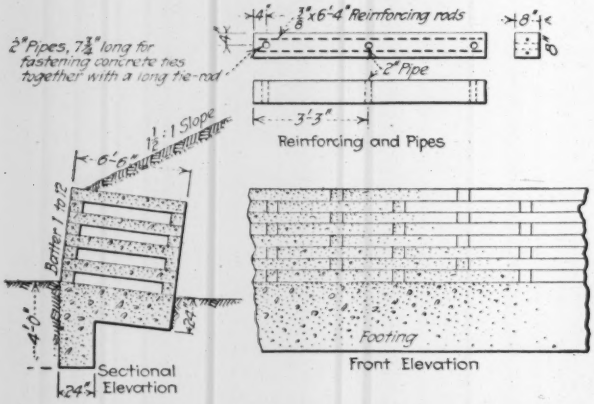


FIG. 8—CONCRETE CRIB WALL ON FOOTING SLAB

Engineers and Contractors—The M. E. White Co., Chicago, has the general contract for grading and concrete work, with C. J. Herlihy in charge as superintendent of construction. Steel bridge work was fabricated by the Wisconsin Bridge & Iron Co., Milwaukee. Bridge erection, track work and the driving of foundation piling are all done by railway forces. About 200 men are employed by the general contractor, working 10-hr. shifts.

A workmen's camp located on high ground at the east end of the work includes ten bunkhouses for twenty-four men each, a washroom with laundry, sink and shower baths, a kitchen and dining room and a reading and rest room. These are frame buildings, sheathed with roofing paper on the outside.

This Milwaukee improvement is being carried out under the direction of Walter J. Towne, chief engineer, Chicago & Northwestern Ry.; J. S. Pole, engineer of track elevation, and G. A. Saint, assistant engineer, with J. M. Gordon as resident engineer in charge. Under the Wisconsin law the railway company pays the entire cost of work on its right-of-way, including paving on street bridges; industries pay for changes in track on their property, and the city pays for bridge approaches and street alterations. The estimated cost for the railway is $1,430,000, while the city will spend about $400,000 on its part of the work. Work was commenced in May, 1922, and it is expected to have it completed by the spring of 1924, operations being carried on throughout the winter.

Building a Small Submarine Oil Pipe Tunnel

Siphon Pipe Lines under Canal by Tunnel in Stiff Clay—Construction Methods—Welded Pipes Rest on Precast Blocks

DREDGING in the Indiana Harbor Canal has necessitated the reconstruction of inverted siphons consisting of pipes laid across the canal at East Chicago, Ind., and forming connections in oil pipe lines leading to refineries at Whiting and East Chicago. It was decided to build a tunnel for these siphons, partly in order to have the pipes accessible for inspection and repair and partly to avoid troubles from deterioration of the pipe due to the pollution of the water by chemicals from industrial wastes. The tunnel, 300 ft. long c. to c. of shafts, is designed to carry two 12-in. and two 8-in. pipes. Its roof has a minimum cover of about 28 ft. at the lowest point of the channel. Views of the construction work are given in Fig. 1.

In section the tunnel is 7x7 ft., with arched roof, as shown in Fig. 2, but at the north end it is increased to 10x10 ft. for a short distance from the shaft in

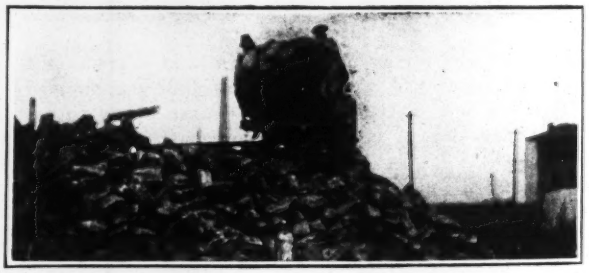


FIG. 1—BUILDING TUNNEL FOR OIL PIPE LINES

Top: form for shaft. Middle: dump pile showing clay blocks dug with pneumatic spades. Below: concrete mixer at shaft and dump cars for muck and concrete.

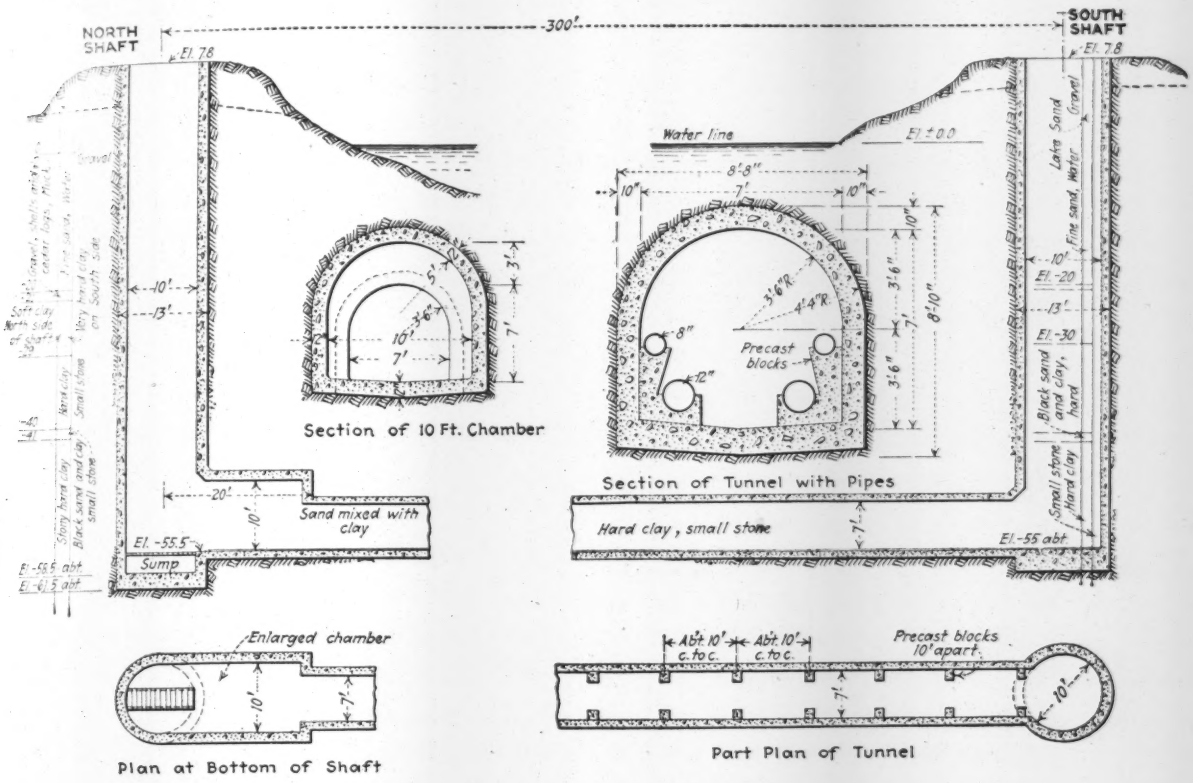


FIG. 2—SIPHON TUNNEL FOR OIL PIPE LINES

order to facilitate the handling and assembling of the pipes. At each end of the tunnel is a 10-ft. shaft about 65 ft. deep. All excavated material was taken out at the south shaft and piled for later use in covering the fire walls around the storage tanks on the adjacent tank farm.

Shafts and Sinking—For the first 25 ft. the shaft excavation was through very fine water-bearing sand, with a few thin layers of gravel. At the south shaft the next 10 ft. was in soft tough clay containing a few small stones. But at the north shaft a peculiar combination was encountered in this 10-ft. lift, the south half of the shaft being very hard tough clay while the north half for about 5 ft. was black muck in which several small red cedar logs were encountered. For the remainder of the shafts the material was tough clay containing a large percentage of small pieces of stone and slate. Little water was encountered after the shafts were sunk a distance of 10 ft. into the clay. The character of the material is indicated by the muck pile in Fig. 1, showing the blocks of clay as cut with pneumatic spades.

Open dredging was used in sinking the shafts to near the level of tunnel roof and they were then underpinned to the bottom. Several small washes occurred in both shafts by sticks and flat stones getting under the cutting edge and cutting small channels outside of the shell. For each shaft there was a cutting edge, Fig. 3, composed of an angle 4x4x½ in. and a plate ⅜x24 in., with anchors ⅝x36 in. spaced 24 in. apart. Wood sectional forms in 4-ft. sections were used for the 18-in. lining, two sets being employed at each shaft. The forms were left in place for 48 hours. The concrete was reinforced both horizontally and vertically by ½-in. square bars spaced 24 in. c. to c.

Equipment for the south shaft consisted of a traveling derrick of 11-ft. gage with a 40-ft. boom and 7x10-in. hoisting engine to handle a ½-yd. clamshell bucket. Air for ventilating the tunnel and for operating the pneumatic shovels or spades used in excavation was supplied by a 10x10-in. compressor with receiver 5x7 ft. and operated by steam from the boiler of the hoisting engine. At the north shaft a 60-ft. guyed derrick with 50-ft. boom and a three-drum hoisting engine 8x10 in. operated a ½-yd. clamshell bucket. Concrete was made at each shaft in a ½-yd. mixer with gasoline engine (Fig. 1) and was placed by the derrick and a bottom-dump bucket. Water was obtained on the south side by a 2-in. gasoline pump connected to well points and was delivered to the north side by a 1¼-in. pipe laid across the bottom of the canal.

Tunneling—Tunnel excavation was handled from the south shaft and was nearly all in tough hard clay containing slate and small stones. In this material the ordinary method was to mine and concrete a length of 6 ft. in each 9-hour shift, and as two shifts were operated the progress was 12 ft. per day. A few small sand pockets were encountered and there the mining, timbering and concreting were done in 3-ft. sections. Each shift consisted of three miners operating pneumatic shovels or spades in the heading, two muckers and two car pushers. The excavated material was handled in ½-yd. steel V-shaped side-dump cars on 14-in. track consisting of 16-lb. rails on ties 4x4x36 in., spaced 3 ft. c. to c. In the shaft these cars were handled on a 5x4-ft. elevator operated by the steam hoisting engine.

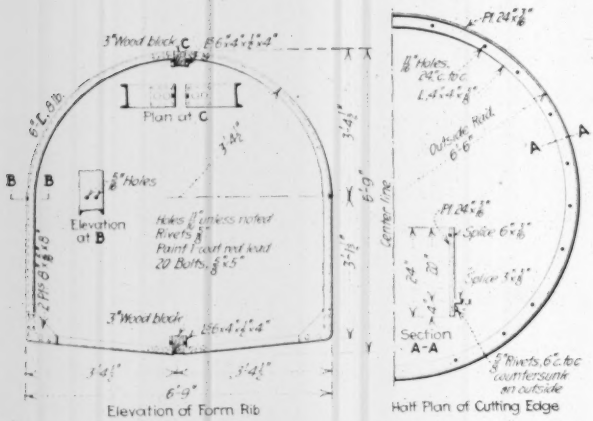


FIG. 3—TUNNEL FORM AND CUTTING EDGE

Steel ribs for the forms, Fig. 3, were made of two 6-in. channels with angle lugs at top and bottom for bolting together, 3-in. wood spacing blocks being fitted between the lugs. Upon these ribs was laid 2x6-in. wood lagging with beveled edges. Gravel concrete of 1:2½:4 mix was used on all the work. For the tunnel lining the concrete was handled in the ½-yd. steel dump cars and then shoveled into the forms and tamped. A medium dry mix was used for the tunnel and a wetter mix for the shafts. At the key or the crown of the arch, concrete was placed from the face of the heading by mining a little in advance of the form and then tamping in the concrete from the face. After completion, the entire surface of the tunnel and shafts was brushed clean and finished with a coat of 1:2 mortar, filling all voids.

Precast concrete blocks, which were made on the outside, are placed along each side of the tunnel at 10-ft. intervals to form supports for the four pipe lines. In the shafts the pipes are held by pairs of 6-in. channels spaced 8 ft. c. to c. All pipe joints in the tunnel and shafts were welded in place. Additional pipe lines can be placed later, as concrete inserts were placed in the tunnel and shaft walls at 10-ft. intervals. At the

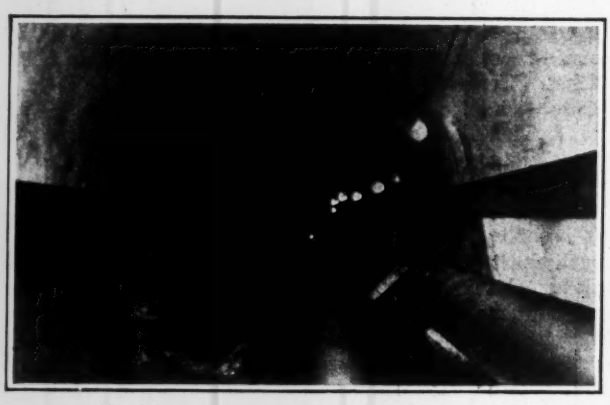


FIG. 4—PIPE LINES IN TUNNEL

south shaft is a manifold building 30x28 ft. where pipes and valves will be installed so that oil from any of the four pipe lines from the oil fields can be delivered to any of the four tunnel pipes. Permanent lights are provided in the tunnel and each shaft has an iron ladder, while a small hand power elevator will be placed in the south shaft. Fig. 4 is a view of the completed tunnel with three pipe lines in place and the fourth lying on the floor.

Provision for expansion of pipes consists simply in giving a slight deflection to the vertical riser at its connection with the horizontal pipe. The movement will be very slight, since the temperature of the oil varies little and with the inclosed tops of the shafts the temperature of the tunnel probably will not vary more than a few degrees. At the north shaft, the connections between the tunnel pipes and risers consist of tees, while elbows are used for the connections at the south shaft. In the shafts the risers are secured to the cross channels by U-bolts or stirrups having clips which engage the flanges of the channels and are secured by the nuts. These fastenings for the riser pipes are shown in Fig. 5.

Lines and grades were established by the contractor. In the tunnel, the grades and points were established by a transit by means of wires and heavy plumb bobs suspended in the shaft. Work was commenced June 16 and the tunnel was holed through Sept. 16, 1923. This siphon tunnel was designed and con-

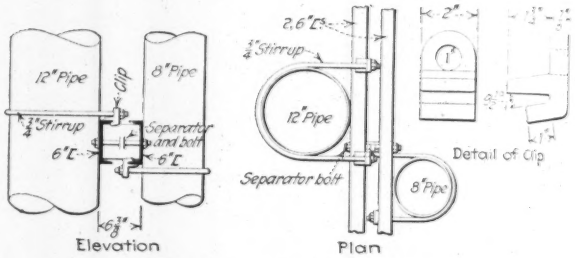


FIG. 5—FASTENINGS FOR RISER PIPES IN SHAFTS

structed by the Subway Engineering Co., Chicago, with E. A. Clark and L. L. Clark in direct charge of construction. It is owned by the Sinclair Pipe Line Co., Tulsa, Okla., and the work was under the general supervision of that company's engineers: Frank Hadley, chief engineer; W. E. Brewer, division engineer, and H. S. Joyce, resident engineer. The estimated cost was about $100,000.

New Grain Elevators for South Africa

With the rapid development of grain-growing in South Africa the old practice of handling individual shipments in bags is giving way to the elevator system, in which the grain is handled in bulk for export. To meet this development, two terminal port elevators and thirty-four country elevators are being built and will be operated by the South African Railways and Harbors Administration. The two terminal elevators at Durban and Cape Town have capacities of 42,000 and 30,000 tons respectively, while the capacities of the elevators at country stations range from 1,800 to 5,800 tons, with an aggregate of 109,200 tons. These works are expected to be completed by the summer of 1924 at an estimated cost of about $10,000,000. Until 1917, the annual grain export did not reach 500,000 bags, but in three years since that time it has exceeded 4,000,000 bags and the export for 1923 was estimated at more than 6,000,000 bags. Further, it is estimated that after paying interest and operating expenses of the elevator system there will be a saving of $2,500,000 in the annual expense of handling and transporting grain.

Can the Curing Period for Concrete Roads Be Cut Down?

Thousands of Tests of Concrete Cured with Calcium Chloride Indicate That It Cuts the Normal Curing Time in Two and Does Not Injure Strength or Soundness

By H. F. Clemmer
Engineer of Materials, Illinois Division of Highways, Springfield, Ill.

Slightly condensed from a paper presented to the American Road Builders' Association, Jan. 17, 1924, at its annual convention at Chicago, Ill.

THERE IS wanted a method for curing concrete pavements that will do away with ponding and the other wetting methods that require a curing period of 30 days. If this period were to be reduced to 14, or even 21 days the saving to the traveling public is worth seeking.

The use of chemicals for accelerating or retarding the set of concrete is as old as the manufacture of portland cement. Those which have been most thoroughly investigated for this use are calcium chloride and its allied salts. It has been generally proven that calcium chloride, when used in the proper amounts, does accelerate set and secure the same strength at the end of 14 days as can be obtained from the use of the various wetting methods in 28 days. The opinion of many engineers, however, is that, although an early strength is secured, a retrogression of this strength occurs later. No long-time tests have previously been available, but the Illinois Division of Highways recently has broken two-year specimens the results of which tests disprove this theory of retrogression.

The exact theory of the action of calcium chloride in accelerating the set or curing of concrete is possibly as remote as the theory of the setting and hardening of cement. Roughly, the action of this chemical is dependent upon its hygroscopic properties and its resulting ability to attract moisture from the air. Due to this same property moisture is taken from fresh concrete, minute capillary channels resulting from its movement to the surface. It is thought that the calcium chloride in turn is drawn into these channels and in this manner penetrates the concrete for a considerable depth and insures the presence of sufficient water for the hydration of the cement regardless of whether the material on the surface remains or is carried away by rain or other agency. This penetration of the chemical into the concrete apparently takes place within twelve hours.

Another objection which has been raised to the use of calcium chloride is that the surface of concrete which has been treated with this material scales and often becomes "mushy." It has been the experience of Illinois in the investigations made, and in the curing of over 1,000 miles of concrete pavement, that no more serious cases of scaling have occurred than on concrete cured by earth or other similar methods. The results of one phase of this investigation concerned with the causes of scaling, definitely assign the most serious cases to excess tamping or belting.

External Treatment—In the investigation of the effects of using surface applications of various kinds and amounts of curing materials, over 500 slabs, 8 x 12 x 30 in., were subjected to the treatments and tested at the several ages for transverse strength. Cylinders, 6 x 12 in., were used as control specimens to check, in compressive strength, the concrete used in making the transverse specimens. The volumetric mix, 1:2:3½, the standard adopted by Illinois for highway construction, was employed. All tests were in accordance with the state specifications.

Since the primary interest was in the strengths obtained in 14- and 28-day periods the greater number of specimens were tested at these ages. However, for the purpose of determining whether or not retrogression in strength occurred at later ages, 60-day, 90-day, 6-month, 1-year and 2-year specimens have also been tested.

Carefully-controlled methods, consistency of mix, gradation of materials and the fact that the same operators made all specimens insured the uniformity of concrete. In all of the work on curing, the modulus of rupture has been considered as a true indication of the completeness of curing. In the curing of a slab 8 x 12 x 30 in. pavement conditions are duplicated in the amount of surface treated. No compressive cylinders were tested.

Series 1 included 260 specimens of which 100 were poured in holes in the ground having sideboards only, 60 in oiled wood forms in the basement of the laboratory, and 100 in concrete forms of 1:4:5 concrete with walls 3 in. thick and 8 in. deep and were allowed to set for 48 hours before the curing specimens were poured. The object in using con-

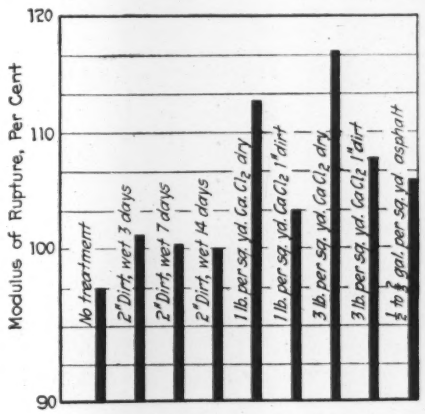

Modulus of Rupture, Per Cent
120
110
100
90
No treatment
2" Dirt, wet 3 days
2" Dirt, wet 7 days
2" Dirt, wet 14 days
1 lb. per sq. yd. Ca Cl2 dry
1 lb. per sq. yd. Ca Cl2 1" dirt
3 lb. per sq. yd. Ca Cl2 dry
3 lb. per sq. yd. Ca Cl2 1" dirt
½ to ¾ gal. per sq. yd. asphalt

FIG. 1—COMPARISON OF 28-DAY STRENGTHS, SERIES 1

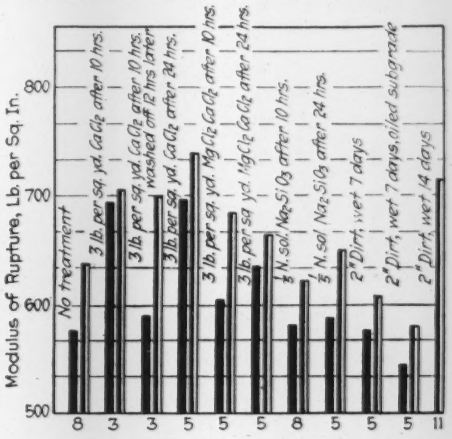

Modulus of Rupture, Lb. per Sq. In.
800
700
600
500
No treatment
3 lb. per sq. yd. Ca Cl2 after 10 hrs.
3 lb. per sq. yd. Ca Cl2 after 10 hrs. washed off 12 hrs later
3 lb. per sq. yd. Ca Cl2 after 24 hrs.
3 lb. per sq. yd. Mg Cl2 Ca Cl2 after 10 hrs.
3 lb. per sq. yd. Mg Cl2 Ca Cl2 after 24 hrs.
½ N. sol. Na2 Si O3 after 10 hrs.
½ N. sol. Na2 Si O3 after 24 hrs.
2" Dirt, wet 7 days
2" Dirt, wet 7 days, oiled subgrade
2" Dirt, wet 14 days
8 3 3 5 5 5 8 5 5 5 11

FIG. 3—RESULTS OF CURING TREATMENTS, SERIES 2

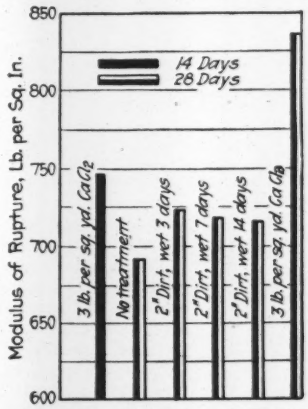


FIG. 2—COMPARING 14-DAY CALCIUM CHLORIDE AND 28-DAY OTHER TREATMENTS

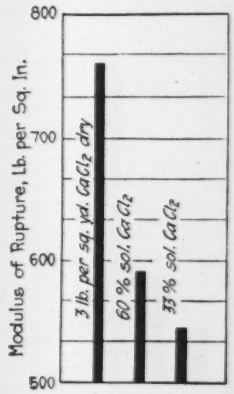


FIG. 4—COMPARING DRY CALCIUM CHLORIDE AND IN SOLUTION

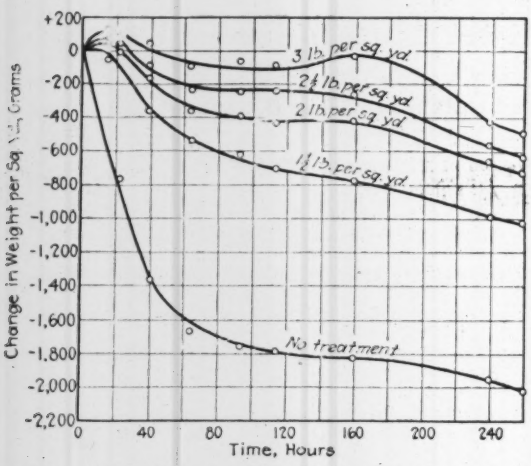


FIG. 5—CHANGE IN WEIGHT OF TREATED AND UNTREATED SPECIMENS

crete forms was to provide a condition which would approximate the curing of a pavement slab, that is, of concrete against concrete.

Care was taken to cover all specimens with a canvas immediately after they were poured to provide protection against weather conditions. All specimens were finished with a trowel and were given their curing treatments the day following. The specimens in this series received the treatment indicated in Fig. 1.

The specimens in Series 2 were poured both in oiled wood forms and in concrete forms. The effect of an oiled subgrade, as well as the use of magnesium calcium chloride and sodium silicate as curing agents, were investigated in this series. The specimens were given the treatment indicated in Fig. 3.

In Series 3 the specimens were cured with a surface treatment of various forms of calcium chloride in order to compare the effect of using dry calcium chloride with that of using solutions of the chemical. In the same series, results were also obtained as a comparison of both flake and granulated forms of dry calcium chloride.

For the purpose of a practical interpretation of the results of Series 1, Fig. 1 has been included showing the 28-day strength of the specimens in percent, using as 100 per cent the strength obtained from the specimens cured with earth wet 14 days. This comparison is especially significant since wetted earth curing is generally considered as satisfactory.

TABLE I—EFFECT OF TAMPING AND EXTERNAL APPLICATION OF CALCIUM CHLORIDE ON CONDITION OF CONCRETE SPECIMENS

Treatment of Surface; Water-Cement Ratio, 0.83	Condition of Surface Age 18 Days
No treatment	Good
1 lb. per sq.yd. $CaCl_2$ after 8 hours	Good
1½ lb. per sq.yd. $CaCl_2$ after 8 hours	Good
2 lb. per sq.yd. $CaCl_2$ after 8 hours	Good
2½ lb. per sq.yd. $CaCl_2$ after 8 hours	Good
3 lb. per sq.yd. $CaCl_2$ after 8 hourx	Good
4 lb. per sq.yd. $CaCl_2$after 8 hours	Slightly scaled
5 lb. per sq.yd. $CaCl_2$ after 8 hours	Slightly scaled—slightly sandy*
6 lb. per sq.yd. $CaCl_2$ after 8 hours	Scaled—sandy
8 lb. per sq.yd. $CaCl_2$ after 8 hours	Very sandy
Flooded with conc. sol. $CaCl_2$ after 8 hours	Good
1 lb. per sq.yd. $CaCl_2$ after 12 hours	Good
1½ lb. per sq.yd. $CaCl_2$ after 12 hours	Good
2 lb. per sq.yd. $CaCl_2$ after 12 hours	Good
2½ lb. per sq.yd. $CaCl_2$ after 12 hours	Good
3 lb. per sq.yd. $CaCl_2$ after 12 hours	Good
4 lb. per sq.yd. $CaCl_2$ after 12 hours	Good
5 lb. per sq.yd. $CaCl_2$ after 12 hours	Scaled**—sandy
6 lb. per sq.yd. $CaCl_2$ after 12 hours	Sandy
8 lb. per sq.yd. $CaCl_2$ after 12 hours	Sandy
Flooded with con. sol. $CaCl_2$ after 18 hours	Good
2 lb. per sq.yd. $CaCl_2$ after 8 hours (excessive tamping)	Slightly scaled
2½ lb. per sq.yd. $CaCl_2$ after 8 hours	Scaled
3 lb. per sq.yd. $CaCl_2$ after 8 hours	Badly scaled
4 lb. per sq.yd. $CaCl_2$ after 8 hours	Badly scaled—discolored
5 lb. per sq.yd. $CaCl_2$ after 8 hours	Badly scaled—sandy

*Surfaces described as "sandy" were slightly soft and had apparently disintegrated to some extent.

**Surfaces described as "scaled" were in such condition that small areas could be lifted with a knife.

As a second interpretation of the Series 1 tests, Fig. 2 is a chart illustrating the fact that greater strength is obtained by the use of calcium chloride in 14 days than by the other blanket methods in 28 days.

Fig. 3 is a graphical comparison of the modulus of rupture of specimens in Series 2 at the ages of 14 and 28 days. To this chart is also added, for purposes of comparison, the 28-day strength of the specimens of Series 1 cured with 2 in. of dirt wet 14 days.

This chart, representing a separate series of tests from those of Figs. 1 and 2, illustrates the same relative value of 14-day calcium-chloride curing over 28-day dirt curing. Figs. 2 and 3 prove the ability of calcium-chloride curing to gain quick strength in concrete. To obtain additional information on the effect of adding the calcium chloride at different times after the concrete was poured, slabs were treated with the material both 10 and 24 hours after making. An experiment was also included to learn the effect of washing the calcium chloride from the slab after it had remained a short period of time. This latter experiment was made to approximate a condition which would obtain in practical work if a rain washed the curing material from the pavement surface shortly after application. The surface of the experimental slab was given a good washing with running water and the calcium chloride entirely removed after it had remained 12 hours. The results show that although removed at this time, the chemical had apparently been absorbed partially by the concrete and a 28-day strength as great as that obtained by wet earth or other recognized treatments was secured.

The comparison of the values of magnesium calcium chloride and sodium silicate for curing is also shown in Fig. 3. These chemicals although apparently satisfactory as curing materials for 28-day periods do not exhibit the properties that secure early strength.

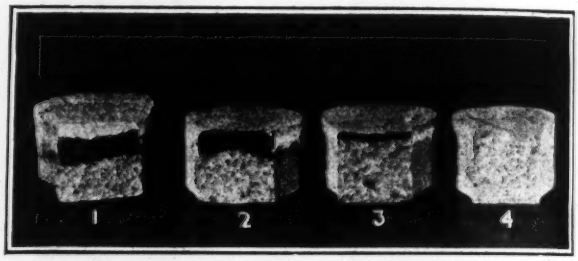


FIG. 6—DEPTH OF CALCIUM CHLORIDE PENETRATION

(1) 8 lb. per sq.yd. applied immediately.
(2) 3 lb. per sq.yd. applied 8 hours after making.
(3) 3 lb. per sq.yd. applied 24 hours after making.
(4) No treatment.

The results of tests on Series 3 are confined to the comparison of the effects of surface applications of dry calcium chloride as compared with the external use of solutions of the chemicals. As illustrated in Fig. 4, 3 lb. per square yard of the dry chemical was found to be far superior in this experiment, specimens cured in this manner having a modulus of rupture much greater than those treated externally with the solutions of both 60 and 30 per cent calcium chloride. It was thought that if the method was found satisfactory, application of a concentrated solution of calcium chloride would be somewhat more convenient and uniform than treatment with the dry material.

A second comparison made by the tests in Series 3 was that between the strengths obtained from the use of the flake and granular forms of calcium chloride applied dry. Practically no difference was found.

In order to determine the extent of penetration, mortar specimens of the same weight were made and treated with varying quantities of calcium chloride including a series of specimens having no treatment. In order to insure against loss of moisture by absorption in the container, these samples were made up on tin plates. After being treated, they were weighed at intervals of one hour and the loss or gain in weight calculated. Fig. 5 shows these weights for the specimens treated by each quantity.

A weight greater than the original was observed on all treated specimens for a period of as high as 45 hours, the untreated specimens however, exhibiting an immediate loss.

The fact that this action is proportional to the strength of the treatment is also apparent and leads to the theory that the hygroscopic chemical freshly applied attracts moisture from the air in proportion to the amount used until the absorbed moisture is in equilibrium with that of the air, after which, by absorption into the concrete and loss by mechanical means, the amount of chemical and, necessarily, water, gradually decreases. This property of calcium chloride to maintain the moisture content of the concrete at a higher percentage during the first 48 hours leads to the belief that the chemical serves to prevent the formation of transverse cracks caused by shrinkage. General observation indicates that fewer transverse cracks occur in concrete pavements cured with calcium chloride than in those cured by ponding or wetted earth. This is being definitely investigated in Illinios at the present time. If found true this fact alone would warrant the application of this material as a curing agent.

Laboratory investigation was made to determine the effect on surface of concentrated amounts of calcium chloride. To illustrate the various effects, tensile briquettes of 1:3 mortar were made and treated. The broken briquettes show clearly the penetration of the chemical and the puffing or scaling caused by the use of concentrated amounts. Fig. 6 shows briquettes that have been treated with various amounts of calcium chloride. The penetration of the chemical is clearly shown in the darkened portion.

Fig. 7 shows the puffing due to excessive use of calcium chloride. These specimens were treated with a surface application of the dry chemical that would amount to about 10 lb. per square yard of surface. It should be noted that the tensile strength of these briquettes at the age of 28 days was not affected by the excessive amount of calcium chloride. Contractors are cautioned however, against the use of excessive quantities and are instructed to break all lumps and spread the material evenly on the surface.

Fig. 8 shows a section of pavement to which calcium chloride is being applied. The ease with which this material

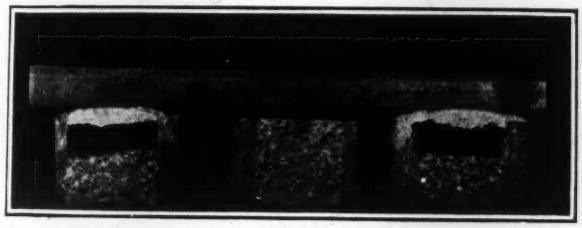


FIG. 7—PUFFING DUE TO EXCESSIVE CALCIUM CHLORIDE

if in proper condition, may be spread is apparent, very little labor being required for the operation. The method of application has been left to the contractor or resident engineer and there have been developed as a result, several implements and methods. The only requirement of the department is that a uniform application be made.

Table I gives the results of a series of tests made in the laboratory for the determination of the cause of scaling. This series of tests included the treatment of 26 slabs, 36 x 36 x 6 in. cast in forms placed in the ground on a level with the surface. The batches were carefully designed and the standard 1:2:3½ mix was used. Application of the calcium chloride was made after periods of both 8 and 12 hours, those slabs receiving the solutions of the material being cast with a slight elevation at the edge to form a trough. Two degrees of tamping were used, that ordinarily employed in the preparation of laboratory samples and an excessive treatment in which three minutes of continuous uniform blows were imposed with a metal tamper having a face 8 x 8 in. and weighing 17.5 lb. The same operator made all specimens as a precaution against any variation due to personal error. Confirming the observations which have been made in the field under practical conditions, the laboratory tests clearly show that the concentration of calcium chloride used in curing is not the important factor in scaling but that the degree of tamping is for the most part the cause. This is due, no doubt, to the fact that under the continuous impact blows of the tamper the relative position of the aggregates is disturbed, segregation of the various sizes occurs, the inert fine materials are

FIG. 8—APPLYING CALCIUM CHLORIDE TO SURFACE OF PAVEMENT

brought to the surface and scaling results regardless of the method of curing which follows.

Wear of Surface—To gain an insight into the wearing value of the treated surface of concrete pavements, several slabs have been cast and at various intervals of age these specimens have been tested in a machine designed especially to approximate the wear of a concrete pavement. Fig. 10 shows the relative wearing value of a surface treated with 2½ lb. per square yard of calcium chloride and one receiving no treatment. The treated surface shows an almost imperceptible wear of 0.024 in. while the untreated surface shows a distinct depth of abrasion of 0.20 in. under the same number of revolutions of the apparatus.

The graphical record, Fig. 10, combines the amount of wear, transverse and compressive strength of one specimen treated with 2½ lb. of calcium chloride per square yard and one having no treatment. These specimens were of exactly the same consistency and both had the same water-cement ratio. The strength specimens were made at the same time and tested at the same time as the wear specimens. A distinct and appreciable advantage in favor of the calcium chloride specimens is observed in this chart.

This wear test is more indicative of the quality of surface concrete than the various tests involving the measurements of penetration into the surface of a steel ball under impact or other force, due to the fact that, although the concrete may yield to some such penetration test and apparently be soft, its resistance to abrasion may be greater than indicated by ball penetration.

The compressive and transverse tests made in conjunction with the determination of wear are checks on the quality of concrete used in making the specimens and again illustrate the superiority in strength of the chemically-cured material.

Use in Construction—Resulting directly from the experiments with calcium chloride, the Illinois Division of Highways recommends the use of the material for curing con-

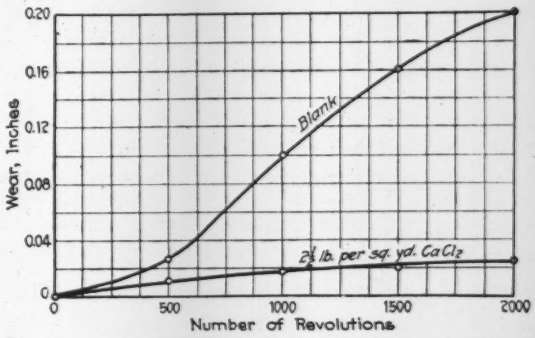


FIG. 9—WEAR OF TREATED AND UNTREATED SPECIMENS

crete pavements; about three-fourths of the total mileage constructed in 1923 was cured in this manner.

In order to acquaint the contractors and resident engineers with the proper use of calcium chloride and furnish information on the various percautions to be observed, a general circular has been issued containing the following instructions on the surface application of calcium chloride.

Calcium chloride may be used in connection with curing of pavements, taking the place of the usual curing with earth and water, or the curing with water by what is known as the "ponding method." Two and one-half pounds of the flaked or granular material (the flaked is preferred as it is more easily distributed

and less easily removed by wind or rain) shall be applied to each square yard of pavement and it shall be distributed uniformly over the surface of the finished pavement by means of a mechanical drilling device or by the use of shovels and long-handled brooms. The material shall not be spread upon the pavement until the latter has thoroughly set—ordinarily from six to eight hours after laying the pavement. Care shall be taken that the material is uniformly spread and if, in the opinion of the engineer, a uniform distribution is not obtained from the shovels, a thorough brooming shall be required. All lumps shall be broken up and uniformly distributed over the surface.

Calcium chloride shall not be applied during rain and experiments have definitely determined that if a rain follows the placing of the calcium chloride after a period of two or three hours there will have been enough absorption of the calcium chloride by the new pavement preceding the rain so that there will not be required additional applications of the material.

Although the water line for curing of pavements with water may be omitted where central mixing plants are operated and

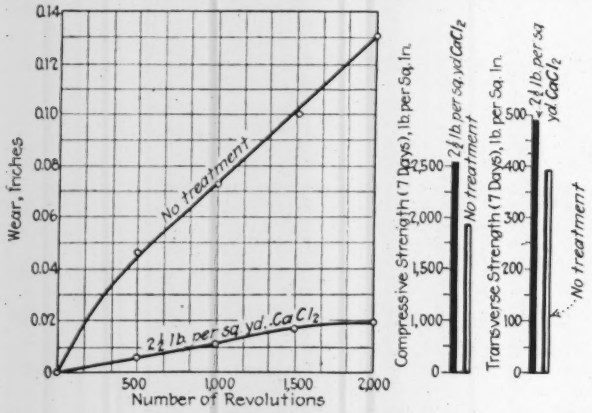


FIG. 10—WEAR, COMPRESSIVE STRENGTH, AND TRANSVERSE STRENGTH OF TREATED AND UNTREATED SPECIMENS

calcium chloride is used in curing; nevertheless the general specifications with regard to wetting of subgrade and the general specifications with regard to placing the burlap on the freshly deposited concrete and wetting of burlap shall be strictly enforced. The use of calcium chloride for wetting the subgrade will not be permitted. When calcium chloride is used in curing, the sides of the concrete pavement shall be banked with earth as soon as the forms are removed.

Considering the actual case of a state that has built or may build in one year 1,000 miles of concrete pavement, our comparison of costs shows that the saving of two weeks on the curing period would effect a saving to motorists of $900,000, a sum large enough, at prevailing prices, to construct 30 additional miles of pavement.

Bridges and Business—Forty Years Ago

It would seem by an article in a prominent daily city paper of the 10th inst. that the board of trustees of the East River bridge are not a unit in their estimate of the value of the structure. One of them is made to say by the reporter that "Our city (New York) is not a jealous city, but then to ask it to build a bridge in order to send its trade to a neighboring city is asking a good deal even from the best of natures." We trust the reporter has misquoted or misunderstood the trustee in stating that the policy of building a bridge from the city of New York to a neighboring city was at this day, in his opinion, a measure of questionable propriety. In our experience we can recall but a single parallel case to this. Many years since a railroad meeting was held in a town in Kentucky, to take into consideration the propriety of building a railroad across the border of the state. A prominent individual in addressing the meeting expressed his views as "in favor of building railroads into Kentucky, but averse to building them out of it," having in his eye, probably at the time, the uncertain tenure of property which could make itself scarce "by an early train."—From an editorial, "The Strength of the Cables of the East River Bridge," *Engineering News*, Nov. 19, 1881, p. 465.)

Carrying Out Mariemont Plan for a Self-Contained Town

Town Planning and Sound Municipal Engineering Along Lines of English Garden Cities for New Suburb of Cincinnati

By Glenn Hall

Resident Town Planner for John Nolen, Cambridge, Mass.

IN THE development of the new town of Mariemont, near Cincinnati, Ohio, modern city planning ideas combined with sound engineering practice are creating a suburb or satellite town that is unique in the history of town planning in the United States. Practically all of the new towns built during the past twenty years have been one-industry communities, constructed and maintained by large corporations for their employees. The war emergency gave a great impetus to new town building and many attractive housing developments resulted.

Mariemont differs from the government and the corporation developments in that it is to be a complete town, with its own civic center and varied industries. In other words, it follows the general lines of the Engish garden cities, such as Letchworth, Hampstead and Welwyn, but has been planned in accordance with American ideas and methods. The purpose of the founder of the town, Mrs. Mary M. Emery of Cincinnati, and her chief representative, Charles J. Livingood, is to demonstrate that a complete, self-contained community, modern in every respect, can be built so that wage-earners of different economic grades can be provided with comfortable homes and pleasant surroundings and that at the same time the project will justify itself from a fair investment standpoint.

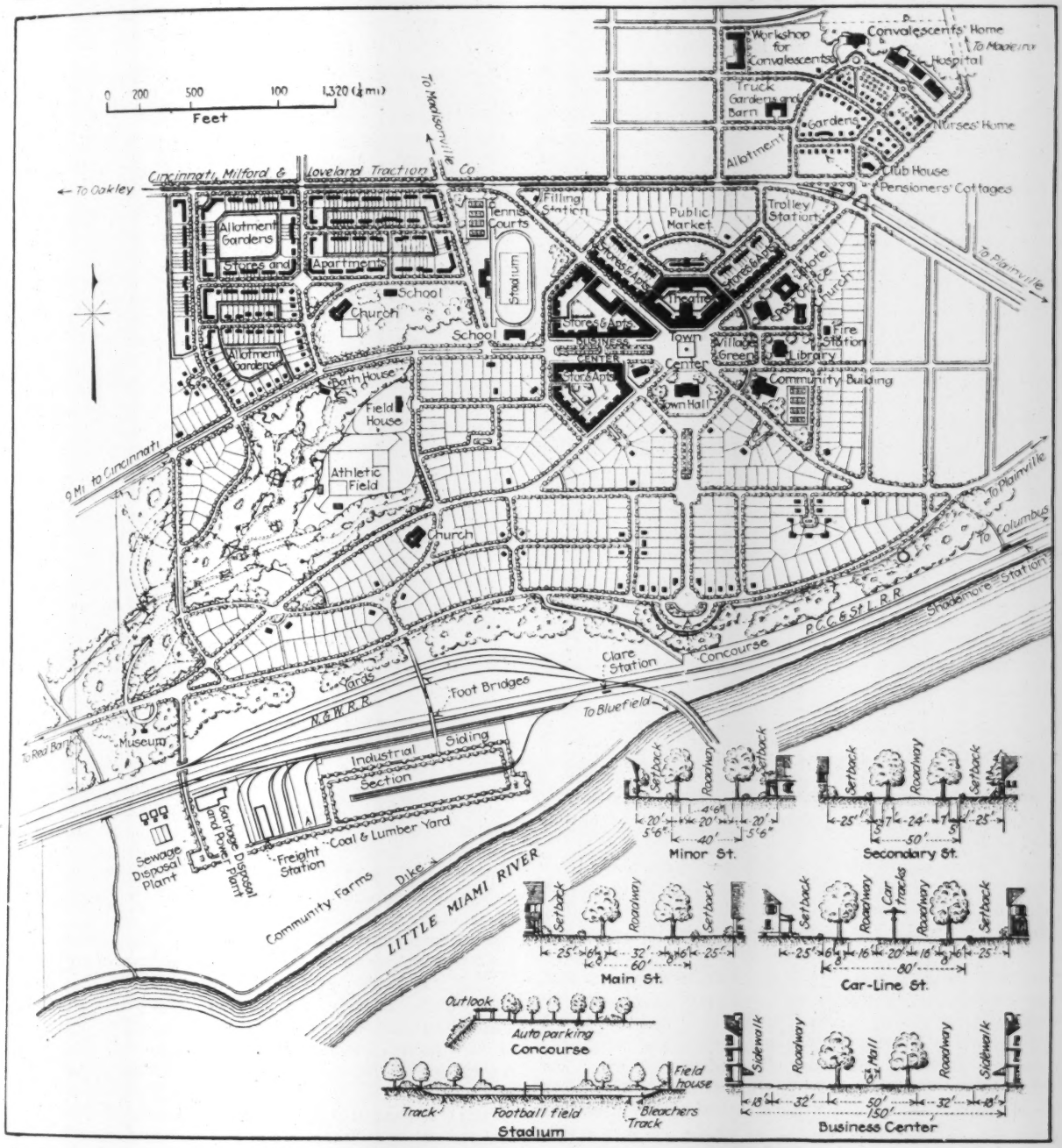
STATISTICAL STATEMENT OF MARIEMONT PLAN

Prepared by John Nolen and Philip W. Foster

Data Herewith Are Based on a Total of 253.58 Acres

Lots	Acreages		Percentages		Lots
Houses	111.52		43.97		Number of House Lots 759
Stores and apartments	10.04		3.97		
Total		121.56		47.94	Houses per net acre 6.81
Semi-Public Properties					
Garage	.89		.35		Average Lot Area
Filling station	.07		.03		15 acres
Hotel	.87		.34		Normal Lot Sizes
Bank	.37		.15		Detached
Church	.55		.22		50x120 ft.
Church and cemetery	1.00		.39		80x120 ft.
Church	.76		.30		Semi-Detached
					30x100 ft.
Total		4.51		1.78	
Public Properties					
Post office	.83		.33		Group
Town Hall	1.88		.74		20x100 ft.
Fire station	.32		.13		
Public market	1.19		.47		Northwest Section
Library	.97		.36		Density per net acre
Community bldgs.	2.57		1.01		11.09
School and stadium	8.59		3.37		
School	1.00		.39		
Parks and playgrounds	51.76		20.45		
Total		69.11		27.25	
Streets					Length of Streets
Forty-foot	10.00		3.95		40 ft. wide 2.2 miles
Fifty-foot	22.84		9.02		50 ft. wide 3.7 miles
Sixty-foot	12.39		4.87		60 ft. wide 1.7 miles
Eighty-foot, carline	8.01		3.15		80 ft. wide .7 miles
150-foot special	5.16		2.04		150 ft. wide .3 miles
Total		58.40		23.03	Total 8.6 miles
Total	253.58	253.58	100.00	100.00	

Industrial Location—The town site has been well chosen for its purposes as an industrial satellite town



TOWN PLAN FOR MARIEMONT, SUBURB OF CINCINNATI

or suburb. It is located ten miles east of Cincinnati, on the main line of the Pennsylvania R.R., adjacent to Madisonville and Plainville and about two miles from the industrial centers of Oakley and Norwood. There are 365 acres in the original Mariemont tract, most of which is level farmland lying on high bluffs above the Little Miami River. An additional tract of 50 acres, of level land, along the Norfolk & Western R.R., and adjoining the original property on the west, has recently been acquired for factory sites. Bottom land along the Little Miami River will also be used for industrial purposes and for community farms.

The Mariemont Plan—The general plan provides for a town center with its village green and public buildings—including town hall, library, community building, post office, hotel, theater, bank, churches, stores and public market. Ample provision is also made for schools and playgrounds, stadium, athletic field, tennis courts, different types of parks and scenic reservations for the public on the bluffs above the river. About one-half of the property is in lots, one-quarter in public property and one-quarter in streets. There are over 50 acres in parks alone and more than 70 acres in parks and other public uses. There are over 750 house lots in Mariemont with an average of less than seven houses to the acre, which meets the standard of the English garden cities. Lots for detached houses will range in width from 50 to 80 ft., with an average depth of 120 ft. Lot sizes

for the semi-detached houses are 30x100 ft. and for group houses 20x100 ft.

The street plan of Mariemont provides easy access to the main points of interest and convenient circulation through the town. The main streets have been laid out to connect with the trunk thoroughfare system of the Cincinnati district. The mall at the business center is 150 ft. wide, with a planting strip or green in the middle. The carline streets are 80 ft. wide, with the car tracks in a parking strip in the center. The main streets are 60 ft. wide with a 32-ft. roadway; secondary streets are 50 ft. wide, with a 24-ft. roadway, and minor streets are 40 ft. wide, with a 20-ft. roadway.

All the houses will be carefully designed and be mostly of brick, local stone or other permanent building material. Apartments will also be built. Modern conveniences, including electricity and perhaps steam heat from a central plant, will be provided. Wires for electricity, telephones, etc., will be placed in underground conduits. The initial cost of transportation development, recreation centers, sewage disposal, water supply, telephones, gas and electric light for dwellings and public places will be borne by the Mariemont Co. Adequate provision will be made for the proper maintenance of the property as a complete town or suburb. The town provides directly for a population of about 5,000, with an immediately surrounding population using the main center of probably nearly 10,000 people.

Instead of the haphazard way in which many suburban communities develop, by first building the houses and then perhaps waiting several years before the streets are paved—with water, gas, sewers and other essential conveniences secured at intermittent intervals—Mariemont is being constructed according to a definite, logical and economical program. All underground pipes and conduits are first being laid. Construction work on the sewerage system was started last May. The laying of the sewers, drains and water lines is now well under way.

All service connections are made to the property lines of lots during the period of laying the main pipes and conduits. This should eliminate the costly possibility of tearing up the street paving afterwards. Since all wires will be in underground conduits, the maintenance of these utilities will be reduced to the minimum and the appearance of the streets will not be marred by unsightly poles and wires.

The next step on the Mariemont program after the pipe lines are laid will be grading of the streets. The sub-base for the permanent paving will be laid to serve as a temporary roadway until after the houses are erected. The blocks will next be graded, before building construction begins. As the houses are completed sidewalks will be laid. Following the street construction tree planting will begin. Trees and shrubs will be set out on all streets.

Parks and Public Buildings—Utilization of the natural features of the town site for the most suitable purposes is noticeable in the Mariemont design. The largest park is located in and around a deep and well wooded ravine extending from near the town center to the southwestern corner of the property. A stadium is to occupy a depression in the topography near the business section. This will give a large open area immediately adjoining the stores and the apartment district—a highly desirable feature not to be found in many towns. In fact the stadium linking up with the parks will form a continuous open area from the center of the town to its western boundary. Many of the public buildings of the town, such as the library, post office and community building, will be situated in a natural beech groove at the town center.

Spaciousness, variety in unity, together with convenience and efficiency, characterize the Mariemont plan, and promise the fulfillment of the hopes of its founders and planners that it may not only produce local happiness, but become "a national exemplar."

Mariemont is being financed by Mrs. Mary M. Emery, of Cincinnati, founder of the town. Her chief representative, Charles J. Livingood of Cincinnati, is President of the Mariemont Co. The town has been planned by John Nolen, town and city planner, Cambridge, Mass., and Philip W. Foster, his associate, who also have the general supervision of the development. Fay, Spofford & Thorndike, consulting engineers, Boston, Mass., are the designers of the sewerage, drainage and water supply systems, and construction is being carried on under their supervision, with George L. Mirick, a member of the firm, as construction engineer, and Warren W. Parks as resident engineer. The writer is resident town planner and landscape architect, representing John Nolen. The John L. Walker Co., Hamilton, Ohio, is the contractor on the sewers and drains. Crumley, Jones & Crumley, of Cincinnati is laying the water lines.

Water-Power Projects Proposed in Canada

The Dominion Water Power Branch of the Department of the Interior in Canada in its review of the hydro-electric progress in Canada during the year 1923 gives a statement of proposed developments in 1924. The report states that the West Kootenay Power & Light Co. is planning to double the capacity of its plant at Bonnington Falls on the Kootenay River in British Columbia. In Northern Ontario the Great Northern Power Co. plans to add a third 2,000-hp. unit at its plant at Indian Chute on the Montreal River. In the Province of Quebec, the Ottawa River Power Co. has already commenced construction on its new plant at Calumet Falls on the Ottawa River. This plant will have an initial installation of one or two 22,500-hp. units and an ultimate capacity of 67,500 hp. Other projects to be started in the near future include a 15,000-hp. plant on the Bastican River, a plant of 80,000 hp. at Lachine Rapids on the St. Lawrence River, a 50,000-hp. development on the Des Prairies or Back River, two projects on the Gatineau River, the first at Chelsea of 110,000 hp. and the other at Paugan Falls of 60,000 to 100,000 hp.; a development on the Megiskan River in northern Quebec of from 10,000 to 20,000 hp. in connection with a pulp and paper mill, and a 21,000-hp. plant on the Du Loup River near St. Paulin. In New Brunswick, the largest undeveloped power site in the Maritime provinces at Grand Falls on the St. John River has been under study by the New Brunswick Electric Power Commission during the past year with the possibility of development being undertaken if all conditions are found favorable. In Nova Scotia, final arrangements have been made by the Power Commission for a second development on East River at Sheet Harbor for a plant having an initial capacity of 6,000 hp. to furnish power to the new plant of the Albany Perforated Wrapping Paper Co. of Albany, N. Y.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

The Railroads' Side of Crossing Elimination

Sir—The editorial in *Engineering News-Record* of March 6, 1924, p. 389, entitled, "Crossing Elimination by Relocation," was apparently written under the impression that railroad officials are indifferent to the grade crossing problem, lacking in foresight and even self-interest in failing to co-operate with highway officials in an endeavor to solve the grade crossing problem. That highway authorities may be unreasonable and inconsiderate in their demands seems to have been overlooked or assumed not to exist. This viewpoint is incorrect, as railroad officials in general are not indifferent, nor unwilling to co-operate to the extent of their ability with highway officials in highway crossing problems.

The editorial expresses the hope that such decisions as that of the Wisconsin Supreme Court "will show many railroad officials the needlessness of continuing to kick against the pricks." While the decision referred to was adverse to the contention of the railroad, nevertheless the contest did bring out forcibly the extreme and unreasonable position taken by the highway authorities, and has had a beneficial effect in showing many highway officials the needlessness of such unfair and unreasonable demands; it also resulted in a very material modification of the law.

The editorial says, "No matter how the crossing is eliminated, whether by separation or relocation, the railroad gains by not having to maintain the crossing or to protect it." However, in most cases the railroad is saddled with a considerable portion of an expensive structure, and frequently with its maintenance. Further on the statement is made that "If, as in the Wisconsin case, the railroad's share of the relocation cost is computed by capitalizing the annual charge for protecting the crossing, then the cost to a railroad for relocation will be much less than for grade separation." In most cases that may be true, but the statement implies that the crossing must of necessity be separated, whereas there are many crossings which could be adequately safeguarded by various means of protection, at very much less expense than for separation.

The difficulty in this connection lies in the contention and the attempted application of the early Wisconsin law, that all of the cost of the highway relocation, or so much of it as would represent the capitalized annual cost of separating the grade, should be apportioned against the railroad, irrespective of the many benefits to the public by reason of the relocation. The relocation illustrated in the article which prompted the editorial was a very simple proposition. In most cases coming under the writer's observation the highway relocations accomplish much more than the elimination of a railroad crossing. In almost every case which has come under my observation the portion of the old highway to be abandoned contained a great many objectionable features in addition to the grade crossing, such as sharp and blind turns, steep grades, narrow and weak bridges, insufficient drainage, low and narrow roadways, poor surface, or other objectionable features. The relocated highway eliminates all these defects fully and, usually, substitutes for an unimproved country road a first-class highway. This is quite proper, assuming that the cost is justified and properly apportioned. But right here comes the unfairness of the contention of the highway authorities, in many places, in that they apportion to the grade crossing elimination capitalization for separating or protecting the crossing which in some cases may be equal to or even exceed the total cost of the relocation. This practice is manifestly unfair. Obviously the relocated highway, with its improved alignment, shorter distance, better grades and drainage, better surface, ample and safe culverts and bridges, the elimination of dangerous turns and other similar betterments has a very considerable increased value to the public.

The value of these betterments can be readily determined and is very large, otherwise what justification can there be for the improved highways for which public funds are being so lavishly spent? The writer contends that all of the betterments in the relocated highway should be summed up, and to these should be added the value of the grade crossing elimination to arrive at the sum total of benefits arising from the relocation; the proportion of the last item so added to the sum of all the betterments will determine the proportion of the cost of the relocation properly chargeable to grade crossing elimination. When this last amount has been so determined it should be apportioned between the state or local highway authorities and the railroad in such proportion as may be established by law, or otherwise fairly determined. The practice of apportioning only a part of the grade separation cost to the railroad is practically universal. If, as is frequently the case, the relocation does not divert from the existing grade crossing all of the highway traffic, then the betterment item due to grade crossing elimination will be less than if the old crossing could be entirely abandoned. The difficulty with many relocations is that they only partially divert the traffic from existing crossings, and in many cases the traffic is not diverted sufficiently to justify leaving the old crossings without some form of protection. Overhead bridges tend to obscure the view of trainmen to adjacent grade crossings and of drivers to approaching trains. Trainmen also become less watchful, as it is generally assumed that drivers are using the overhead bridge.

How dangerous is a railroad grade crossing? The writer does not desire to be understood as claiming that there is no element of danger, nor even that it is negligible, but he believes the danger element is too often overstated. Especially is this true relatively to the many other dangerous conditions incident to highway traffic. Narrow roadways, sharp and blind turns, roadway obstructions, restricted bridges and culverts, reckless driving and glaring headlights are all dangerous conditions which take a large toll of injuries, life and property. Highway authorities seem to be largely indifferent to these evils, the correction of which would bring a much more prompt and larger degree of safety, and at much less expense than can possibly occur with any program for grade crossing elimination. The dangers just mentioned are constant and continuing for each hour of the day and for every passing vehicle; on the contrary, railroad grade crossings have no possibility of danger excepting for the few seconds or, at most, the one or two minutes during which a train is approaching and passing the crossing. Given ten trains a day, which is a quite liberal allowance for the traffic over the greater number of crossings for which separation is now being demanded, the danger exists for not more than ten to twenty minutes out of the 1,440 each day, making the crossing a source of danger for but about one per cent of the total time. These facts clearly indicate that, considered merely from the financial aspect, there would be, generally speaking, no economy in grade separation for the railroads. The analysis is referred to to bring out, as it does, the comparative infrequency of dangerous grade crossing conditions.

It is pertinent here to call attention to the frequent misconception of the dangers of grade crossings, in that all are frequently assumed to be equally dangerous. Your own statement that "railroad grade crossings on heavily traveled highways must and will be eliminated" is an illustration. Heavily traveled highways frequently cross branch lines of railroads over which there are but few trains. Throughout the country there are many branch line railroads with infrequent train service, often not more than four or six trains a day, with the visibility and other conditions favorable, yet many highway authorities put such crossings in the same class with those of highways of no greater importance but crossing the main lines of railroads where the number of trains is much larger.

In order to get some measure of the extent of the grade crossing danger, the writer recently had the records of the railroad with which he is connected, embracing nearly 12,000 miles of line, examined to ascertain the costs to the railroad of all accidents at grade crossings. For the four years 1918 to 1921 inclusive the railroad paid out for investigation, legal and other expense and settlements of all kinds on account of grade crossing accidents an average per year per grade crossing of all kinds $12.93. Capitalized at 6 per cent the cost per grade crossing is $215.

The courts have repeatedly held that travel on the high-

way, whether by vehicle or otherwise, was required to exercise care in approaching and crossing railroad tracks, and has of late in many cases held that the railroads might recover damages arising by negligence of drivers running into trains, etc.; these decisions clearly indicate that a large share of responsibility for the dangerous condition of railroad crossings rests with the public using the highways.

Much publicity has recently been given to the special message of Governor Smith to the Legislature of New York, referring to grade crossing elimination. He says there are 4,000 or more dangerous crossings (so-called) in the state, which the Public Service Commission estimates will require $400,000,000 for elimination, this estimate being exclusive of crossings of electric railways and crossings in New York City. The statute provides that the expense of elimination shall be apportioned one-half to the railroads and the other half divided equally between the state and the municipality or other local authority. The governor says:

> "At the present time most of the railroads are in no position to finance such a comprehensive grade crossing elimination plan, no matter whether grade crossing eliminations are regarded as a capital expense or an operating expense. Similarly, a great many municipalities are face to face with the constitutional debt limit. There is no cure for this situation except in a constitutional amendment, which will permit the loaning of the state credit to railroads and municipalities so that their share of the cost of eliminations may be financed in the first instance by the state, which will thereafter be repaid in annual installments for interest and sinking funds on the bonds in the same proportion that railroads and localities now contribute to grade crossing eliminations."

Later in the message he says, "I shall shortly have prepared for presentation to your Honorable Bodies a constitutional amendment to carry out the program above outlined. This amendment will be so drawn as not to require after its adoption any subsequent vote of the people for the issuance of grade crossing bonds, and it will place the full power of the state behind the grade crossing elimination program."

The editorial refers to the financial inability of the railroads but brushes it aside as though it were a pretense for non-co-operation, or was otherwise of no consideration. But the governor of New York, with a responsible and practical contact with the situation, realizes, as railroad officials to their sorrow have been forced to do, that insufficient funds for improvements of this nature is a very real and serious matter, not only for the railroads but equally so for the municipalities. The recommendation of the governor is, in some respects, similar to the plan in effect for some years past whereby the city of Buffalo, N. Y., has issued bonds for certain grade separation improvements, the railroads reimbursing the city by annual payments through a term of years for their share of the cost.

Governor Smith's message is exceedingly interesting in bringing out the immense expenditures involved in grade separation programs. To accomplish the same result by highway relocations would probably cost nearly as much. The problem is equally huge in other states, perhaps even more so, for, while there may not be quite as many so-called dangerous grade crossings per unit of area or mile of railroad, the financial ability of the local taxing authorities and of the railroads is certainly less than in New York.

The governor's message refers to the appropriation, on his recommendation, of one million dollars for the state's share of grade separation in 1923. That seems like a very large sum, but it is worth while noting that at that rate it would take the state of New York four hundred years to get rid of the crossings now considered as dangerous.

A number of states have statutes requiring that vehicles be stopped before crossing railroads and some others require that motor buses and other similar public service vehicles should stop. The article which inspired your editorial quotes a statement of the U. S. Department of Agriculture, as follows, "There is only one safe way to prevent accidents where highways and railways intersect. That is by a complete separation of grades by means of a subway or viaduct," and further on from the same source it is stated that "the agitation for stopping highway traffic at railroad crossings is having the effect of rapidly crystalizing public sentiment against all grade crossings and this will lead to the only right solution of the matter; that is the separation of grades." Such sweeping generalizations are puerile and are unworthy of the source to which they are ascribed. The last quotation refers, doubtless, to the statutes in a number of states requiring highway traffic to stop before crossing railroad tracks. Such a regulation contributes enormously to safety of highway traffic; and would obviate the necessity of spending huge sums for crossing elimination by either separation or relocation. In this and many other cities vehicles are required to stop before crossing or entering boulevards and other important thoroughfares, with the result that accidents have been very largely reduced. The public appreciates the wisdom of this regulation and there is no complaint regarding it except by the few reckless drivers who disregard the law. Similar statutes made effective in all states would bring an immunity from accidents not only to so-called dangerous crossings, but for all crossings; would involve no cost; would save tax payers of the state of New York $200,000,000, and those of other states similarly large sums; and would leave the railroads with funds to make many more needed improvements. Such a remedy could be put into effect in a few months, whereas the alternative of elimination or relocation will require several generations.

The writer again disclaims a lack of appreciation of the dangers existing under present conditions. He is not contending that these should be ignored or temporized with. On the contrary, he believes that a serious problem exists which should have the deliberate and unbiased consideration of practical minds which will carefully weigh all of the factors of the problem and determine upon a remedy which will give relief, not for the great number of crossings at some far distant period but soon for all and at a cost which will come within the bounds of practicability.

C. F. LOWETH,
Chief Engineer,
Chicago, Milwaukee & St. Paul Railway Co.

Chicago, Ill.,
March 22, 1924.

Concrete Hazards and Surety Bonding

Sir—I have read with great interest the account in *Engineering News-Record*, Feb. 7, 1924, p. 239, of the collapse of a reinforced-concrete hotel at Benton Harbor, Mich., and your editorial on the subject. In view of recent criticisms of the underwriting methods of surety companies on construction contract bonds it will interest your readers to learn that we called the attention of underwriters to the special hazards of concrete as long ago as August, 1915. From the writer's address on contract bonds delivered at the annual convention of the National Association of Casualty and Surety Agents, Detroit, August, 1915, I quote the following:

"*Physical peculiarities* (concrete, stone, hardpan, vegetable fiber, etc.): Each of these substances has, in one way and another, lost hundreds of thousands of dollars of surety companies' money. In concrete, by the collapse of buildings and bridges due to insufficient reinforcement, too great haste in doing the work, concrete frozen by reason of being mixed and poured in cold weather, and general inexperience and incompetence on the part of the contractor handling it. Each year concrete comes more into general use in contract work and contractors become better equipped for its satisfactory employment. At present, it is necessary for contract underwriters to recognize that it presents a special hazard and to take great care that they bond only those contractors who have the experience and the skill requisite to the proper handling of concrete material.

"*Time:* The time in which a contract is to be completed is an essential element of the risk; and if the time is unduly short then time alone may itself constitute a special additional hazard. This is especially true of concrete work where too great haste may result in the entire collapse of the building because the concrete has not been given sufficient time to 'set.'"

Thus, surety underwriters received due warning of this special hazard nearly nine years ago.

R. H. TOWNER.
Towner Rating Bureau
New York City, March 12, 1924.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

News Brevities

Rights to Divert Water for Power purposes from the South Yuba River in California have been issued to the Excelsior Water & Power Co. of Smartville, Calif. The estimated cost of the project is $204,000.

Work on the New Tube Station of the Hudson and Manhattan Railroad Co. at the Erie R.R. Station in Jersey City will be started in the near future according to an announcement from the company. The estimated cost of the work is $700,000.

Tax Exemption for Dwellings in New York State has been extended for another year by a legislative act approved by Governor Smith on April 1. The exemption will hold until 1932 on dwellings, the construction of which is started before April 1, 1925, providing a local ordinance to that effect is adopted.

Contracts for the North End Bridge in Springfield, Mass., were let March 25. The P. T. Cox Contracting Co., New York City, was awarded the contract for the substructure at $353,818; and the American Bridge Co. the contract for the superstructure at $520,371. Two entirely new piers must be built at the Springfield end, so that superstructure work is not expected to be started much under three months.

The Commission Council of Buffalo, N. Y., on March 28, was held in contempt of court for not having obeyed an injunction issued July 25, and effective Sept. 15, 1923, and since affirmed by the Appellate Division of the State Supreme Court, against the continued operation of a garbage piggery maintained by the city in the town of Tonawanda. The city was given a thirty-day period of grace before the contempt order goes into effect.

A Return from the Commission Plan of city government in force at Rahway, N. J., for the last six years to the former mayor-and-council plan was ordered March 26 by a popular vote of 2,922 to 981. The voting was heavy, the total number of votes cast being some 800 more than at the last November election. A part of the heavy vote in favor of returning to the councilmanic plan seems to have been due to a strong wave of feeling against the commission mayor, who is reported to be a Socialist and to have refused recently to take part in a veterans' parade. Directly after the election petitions for the recall of the mayor were put in circulation, whereupon he resigned. The change back to the old plan will be made Jan. 1 next.

Structural Engineers Form Division of Am. Soc. C. E.

A number of structural engineers in the membership of the American Society of Civil Engineers have undertaken to form a structural division of the society, and have petitioned the board for approval of a division organization, according to the rules. It is expected that the matter will be passed upon by the board at the Atlanta meeting of the society, April 8. Prof. C. T. Bishop, New Haven, and William G. Grove, New York, have been active in the organization work.

To Finance Delaware River Water Resources Commission

A bill has been introduced into the New York State Legislature appropriating $25,000 for the expenses of the Delaware River Water Resource Commission. This commission was appointed in 1923 to meet with similar commissions from the States of New Jersey and Pennsylvania to negotiate and agree upon the terms of a treaty between the three states and the Government of the United States covering all matters relating to the conservation, use, and development of the water resources of the Delaware River Basin. The three members of the commission for New York are Rudolph Reimer, Jr., Col. Jefferson De Mott Thompson, and George McDonald.

Power Commission Recommends Changes in Federal Act

A bill has been introduced into the upper house of Congress upon recommendation of the Federal Power Commission, proposing five amendments to the Water Power Act. These amendments provide that the commission employ its own personnel rather than borrow employees from the War, Interior, and Agricultural departments, who are paid out of appropriations for those departments; that the sole authority to issue licenses for power development and to conduct investigations with respect to them be placed with the commission; that the commission be empowered to take jurisdiction over permits and licenses issued under legislation prior to the passage of the Water Power Act; that monies now collected for the administration of the act be made available for that purpose; and that the commission be empowered to make more complete utilization of lands withdrawn for power purposes. The commission is greatly handicapped by a lack of personnel directly under its own control and although there is sufficient income to the government from licenses, etc., to cover the cost of adequate personnel these funds now go to other departments.

Los Angeles Adds Three Storage Dams to System

Aqueduct Soon to Be Supplied by Reserve Water Aggregating 18,000 Acre-Ft. in 3 Structures

The City of Los Angeles is now completing three dams that are to afford desired storage facilities in as many parts of the territory served with water from the Los Angeles aqueduct. Two of these structures, located in the Santa Monica mountains, are earth-filled dams and the third, in the hills back of Hollywood, is an arch concrete dam. These structures are being built in accordance with the policy of the Los Angeles department of public service that "necessity demands and the present program is to provide all possible storage at the southerly terminus of the aqueduct in order to prevent winter waste of water."

Hollywood dam in the Hollywood hills just east of Cahuenga Pass is a concrete structure arched on a radius of 542 ft. On March 20 this dam had reached a height of 90 ft. and was expected to be completed to the total height of 200 ft. in February 1925. This dam is to contain 175,000 cu.yd. of concrete and store 7,000 acre.-ft.

Stone Canyon dam on the south slope of the Santa Monica mountains, about 6 miles northeast of Santa Monica, on March 20 had been brought to a height of 172 ft. and the total height of 180 ft. was to be reached by May 1.

The capacity of the reservoir will be 7,500 acre-ft. which will serve the Westgate district and will "double-end" the system supplying the west and southwest portions of the main city.

Encino Dam

The other earth structure, known as Encino dam, is on the north side of the Santa Monica mountains and is to maintain pressure in the extensive distribution system in the San Fernando valley. Heretofore the south side of this valley has been dependent on the mains that carried the supply across the valley and when other parts of the valley draw heavily on the system the pressure along the south side has been affected. Encino reservoir is therefore rated as an "equalizer" and will ordinarily function without control gate, that is, there is but one pipe through the dam and the valve in this line will ordinarily be open, thus maintaining pressure by letting the reservoir storage supplement the supply in the system when the demand is high and when the demand is low, drawing from the system to maintain the normal level.

Encino dam is 120 ft. high, contains 500,000 cu.yd., and was built entirely by the dryfill process, the material being sprinkled and rolled continually as it was placed. Its storage capacity is 3,348 acre-ft.

Nelson P. Lewis Dies

Former Chief and Consulting Engineer to New York City Board of Estimate Dead at 68

Nelson P. Lewis, who had served the City of New York in an engineering capacity for more than thirty years prior to his becoming, in 1922, director of the Physical Survey of the Plan of New York and Its Evirons, died March 30 at his home in Brooklyn at the age of 68 years. He had been in ill health for some months and late in January went to the hospital for an operation. Another operation was performed in mid-February, but his condition at that time was not thought dangerous.

Mr. Lewis was born in Red Hook, N. Y., Feb. 1, 1856. He received his early education at the Red Hook Academy, was graduated from St. Stephen's College at Annandale, N. Y., in 1875 with an A.B. degree and then entered Rensselaer Polytechnic Institute, from which he was graduated with a civil engineering degree in 1879. For five years after his graduation Mr. Lewis was engaged in railroad engineering, first on location and as a resident engineer on the construction for the Union Pacific and Denver & Rio Grande in Colorado and later in a similar position for the Vicksburg, Shreveport & Pacific R.R. in Louisiana. In 1884 he was connected for a short time with the Delaware & Hudson R.R. and later in the same year entered the service of the city of Brooklyn, where he was engaged in water-works extension.

Returns to Brooklyn

In 1886 Mr. Lewis again turned to railroad work and spent three years in the service of the Central R.R. of Georgia. He returned to Brooklyn in 1889 and resumed work for that city as an assistant engineer. After five years of experience in various branches of municipal work, he was placed in charge of the Bureau of Highway Construction and Repair, which he reorganized and placed on a thorough engineering basis. When Brooklyn became part of Greater New York, Mr. Lewis became chief engineer of the Bureau of Highways of that borough, a position which he held until 1902, when he was made chief engineer of the Board of Estimate.

On account of his extensive experience in municipal engineering problems, Mr. Lewis' services on special commissions were frequently sought. In 1904 Mayor McClellan named him a member of the New York City Improvement Commission and in 1905 he was appointed to the commission on municipal electric lighting. Later he served on the Heights of Buildings Commission, a body whose work led eventually to the adoption of the zoning scheme in New York City.

Mr. Lewis always displayed a keen interest in the design, construction and economic features of highway improvement. He was a United States representative at the International Road Congresses at Paris in 1908, at Brussels in 1910, and at London in 1913. His contact with foreign affairs was further strengthened in 1913 by attendance at the International Congress of Cities, held at Ghent, and in December, 1918, he was one of nine engineers invited by the French Society of Civil Engineers to visit France and study its engineering problems under war conditions.

As an authority on city planning, Mr. Lewis had received wide recognition. In addition to his book on "Planning of a Modern City," he had written many papers on the subject and delivered numerous lectures at engineering colleges and before technical societies. He was prominent in the City Planning Conferences from their inception and was at one time president.

He retired from active municipal service on Nov. 15, 1920, after thirty-four years' service with the City of New York. After retirement, though he did not open a consulting office, he was retained as consultant by the City Planning Board of Boston and later became consulting engineer to the Board of Estimate of the City of New York and still later director of the physical survey of the Plan of New York and Its Environs, a survey being made under the supervision of the Russell Sage Foundation.

Subway Bills Up in Philadelphia

Bills providing for subway construction in Philadelphia were introduced in City Council at a meeting held in March. These bills provide funds for the construction, and give authorization to the Department of City Transit to proceed with the construction of Step No. 1 in the comprehensive transit plan approved last November. The bills were referred to the Committee on Transportation of City Council. The Department of City Transit is now planning for enlargement of its staff.

Professional Men Unite

There has been organized in St. Paul the International Professional Men's Club. The new organization is the national body which comprises eight local clubs organized in the past two years in Des Moines, St. Paul, Minneapolis, Duluth, Milwaukee, Kansas City, Omaha and Sioux City. In the national organization's official staff is one engineer, J. C. Pinney, head of the department of engineering of Marquette University, who was elected a director. The president of the new organization is Thomas R. Kimball, Omaha, former president of the American Institute of Architects.

The club was formed to unite in good-fellowship men engaged in the practice of any of the professions, to foster the ideals of each profession and to give members a better understanding of each profession's special problems. Those eligible to membership are architects, artists, authors, chemists, clergymen, dentists, educators, engineers, lawyers and physicians.

Longley Returns After Absence of Five Years

Col. F. F. Longley, formerly with the firm of Hazen & Whipple, consulting engineers, New York, and during the war in charge of the water supply section of the office of the chief engineer, American Expeditionary Forces, in France, has just returned to the United States after spending almost five years in Europe and Australia as a specialist in sanitary and public health engineering for the League of Red Cross Societies and for the Rockefeller Foundation. After the war, Col. Longley returned to Europe in 1919 to become director of the Division of Sanitary Engineering of the League of Red Cross Societies, with headquarters at Geneva. In this capacity for two years he devoted himself to problems of municipal sanitation in Central and Eastern Europe, his duties involving extensive travel through Poland, Czecho-Slovakia, Austria, Servia, Italy, Sweden, France and Belgium. In November, 1921, as a technical representative of the Rockefeller Foundation, he went to Australia to become advisor on sanitary engineering to the Department of Health of that commonwealth, with headquarters in Melbourne. In this capacity he co-operated with state officials, health officers, engineers, and members of municipal councils on a variety of sanitary engineering problems, including water supply, sewerage, sewage treatment, garbage and refuse collection and disposal, drainage and mosquito extermination. He devoted particular attention to the garbage and refuse problem in Sydney and to sewage treatment in Brisbane. He advised also on sewerage and city planning problems connected with the establishment of the new Australian federal district and city of Canberra, in New South Wales, which is being developed as a national capital on lines camparable with those undertaken in Washington, D. C., a century ago.

New Building Congresses Formed

Noteworthy results on the part of the American Construction Council in the organization of new construction congresses are given by D. Knickerbacker Boyd, executive vice-president of the Council in a report to its president, Franklin D. Roosevelt, in which Mr. Boyd describes his recent trip to the Pacific Coast which he spent as a representative of the Council. Two new construction congresses were organized as branches of the American Construction Council—one in Denver and one in Minneapolis. At Denver, machinery for a permanent congress was set in motion by the election of William M. Bowman and Elmer McPhee as temporary president and secretary, respectively. At Minneapolis the new congress was created through the appointment of an organization committee.

The former Washington State Congress, which had been inactive since its first meeting about two and a half years ago, was reorganized as the Seattle Association of Building and Construction affiliated with the American Construction Council.

Motor-Vehicle Traffic Conference To Be Held at Yale University

A conference on motor-vehicle traffic, with special reference to regulation, control, and safe operation, will be held in New Haven, Conn., April 9-11, under the joint auspices of the state of Connecticut and Yale University. Funds to defray the expenses of the conference and to provide for printed proceedings have been given by Mrs. Helen Hartley Jenkins, of New York City, through the Hartley Corporation, of which Mrs. Jenkins is president.

The causes of more than 15,000 motor vehicle accidents which happened in Connecticut during 1923 have been analyzed by the Department of Civil Engineering of Yale University in cooperation with the department of motor vehicles of Connecticut. These accident statistics will be presented at the opening session on Wednesday, April 9. This will be followed by a discussion of "Laws Governing Traffic" and by a paper on "The Mind of the Operator." Under the general topic of "Accident Prevention," papers will be presented on Thursday, April 10, on "The Education of School Children and the General Public," "Laws and Court Systems," "Highway Improvement," "Traffic Regulation and Control," "Police Methods," and "Motor-Vehicle Department Procedure." The third day, Friday, April 11, will be devoted to a discussion of Specific Connecticut problems such as "Highways," "Street Railways," "Public Service Motor Vehicles," "The Traffic Policing of Highways," and "The Traffic Policing of City Streets."

Among those who will present papers during the conference are W. M. Maltbie, judge of the Superior Court of Connecticut; T. W. Salmon, associate professor of psychiatry of Columbia University; A. M. Meredith, commissioner of education of Connecticut; E. G. Payne, professor of education of New York University; Col. Frederick Stuart Greene, superintendent of the Department of Public Works of New York; W. P. Eno, Washington, D. C.; A. F. Foote, commissioner of public safety of Massachusetts; D. A. Adams, secretary of the New Haven Automobile Club; W. L. Dill, commissioner of motor vehicles of New Jersey; R. B. Stoeckel, commissioner of motor vehicles of Connecticut; J. A. Macdonald, highway commissioner of Connecticut; L. D. Storrs, president of the Connecticut Co.; R. T. Higgins, chairman of the Public Utilities Commission of Connecticut; R. T. Hurley, head of the state police of Connecticut; G. H. Farrell, chief of police of Hartford, Connecticut; P. T. Smith, chief of police of New Haven.

New Brunswick to Develop Power

Definite announcement that the government of New Brunswick will undertake development of Grand Falls on the St. John River as a public ownership proposition has been made by the prime minister of the province. It is intended to develop at present the power which would come from storage possibilities on purely Canadian territory which would run from 60,000 to 80,000 hp.

Committee to Plan Road Program for California

Governor Richardson, of California, acting in accordance with provisions made by the last legislature, has appointed a committee of nine which is to prepare for the 1925 legislature recommendations as to future policy in conducting the work of the California State Highway Commission. It is understood that this committee will consider ways and means of financing additional road work and will consider the inclusion in the state system of additional roads which it is believed should be under state jurisdiction.

The committee consists of A. H. Breed, representing the state senate; Elmer Bromley, representing the assembly; George G. Radcliff, representing the state board of control; Louis Everding, state highway commissioner; Robert M. Morton, state highway engineer; A. E. Loder, engineer, California State Automobile Association; E. E. East, engineer, Automobile Club of Southern California; J. B. Gill, former San Bernardino county highway commissioner; and J. H. Newman, former Tulare County supervisor.

In a statement recently issued by the California State Highway Commission it was pointed out that state highway funds are nearing exhaustion and that the approximate $11,000,000, available for primary construction is in large part composed of federal-aid funds. To date, the announcement states, California has sold $70,000,000 in state highway bonds and it is estimated that the completion of the state highway system will require a future outlay of at least $200,000,000.

Chicago Water Diversion Case To Be Heard in November

The appeal of the Sanitary District of Chicago from the decisions of the lower courts in favor of the federal government to restrain the district from diverting from Lake Michigan more than 4,167 sec.-ft. of water will be heard by the United States Supreme Court Nov. 10. The court recently announced that it had granted the motion of the solicitor general of the United States to advance the case, the November date being set for the appeal.

Attorneys for the Sanitary District had resisted the application to advance hearing of the case, asking that it take its regular course in the Supreme Court in order that there might be opportunity for Congress in the meantime to take action on one or more of the several bills which would affect the situation, among them a bill to permit diversion of 10,000 feet of water into the sanitary canal and others having to do with a proposed 9-foot channel to connect Lake Michigan with the Illinois and Mississippi rivers, through the sanitary canal.

The federal government won its suit to prevent excessive diversion by the Sanitary District last year, on the ground that excess diversion had the effect of diminishing the surface elevation of the Great Lakes, excepting Lake Superior. The District appealed.

Recognized Paving Brick Varieties Again Reduced

Eliminated Variety Is 3½x3½x8½-in. Wire-Cut Lug Brick—Five Varieties Remain

Meeting in Washington March 28, the Standing Committee on Paving Brick Varieties, operating under the Division of Simplified Practice of the U. S. Department of Commerce, eliminated another variety from the recognized list, thus reducing the number to five. The eliminated variety is the 3½x3½x8½-in. wire-cut lug brick (Dunn type), in which shipments have declined from 4.1 of the total paving brick shipments in 1920 to 0.9 per cent in 1923. The five remaining "recognized" varieties, with the percentage they represent of total shipments, are:

Plain wire cut (vertical fiber lugless)
3x4x8½ in. 38.8%
3½x4x8½ in. 13.7%
Repressed lug
4x3½x8½ in. 18.2%
Wire-cut lug (Dunn type)
3x3½x8½ in. 2.3%
4x3½x8½ in. 6.4%
Shipments represented by five "recognized" varieties 79.4%

Believing that a guiding formula was desirable in its future work, the committee adopted this resolution:

"That any type of brick which shows less than 2½ per cent of shipments for successive years be eliminated from the list of recognized varieties and that any type which shows 5 per cent or more of shipments for three successive years be reinstated, unless special technical or other reasons show that such action is undesirable, and provided also that the recognized varieties shall represent not less than 75 per cent of shipments."

Plain Wire-Cut Shipments Grow

For the year 1923 the survey of shipments showed a continuance of the increase in use of the plain wire-cut brick (vertical fiber lugless) that has been marked in recent years, the percentage of this type to total shipments increasing from 48.1 in 1922 to 56.0 in 1923. At the same time the use of lug brick has continued to decline.

Total shipments reported in the survey were 453,800,000 brick, which is 92 per cent of the normal capacity of the industry, and represent the industry's biggest year.

The members of the Standing Committee and the organizations they represent are P. St. J. Wilson, Bureau of Public Roads; Col. R. K. Compton, American Society of Civil Engineers; George F. Fisk, American Society of Municipal Improvements (absent from this meeting, but represented by Col. Compton); O. W. Renkert, American Ceramic Society; Edward E. Duff, Jr., National Paving Brick Manufacturers Association; Will P. Blair, American Society for Testing Materials; Leon C. Herrick, American Association of State Highway Officials; E. W. McCullough, U. S. Chamber of Commerce; P. H. Bates, Bureau of Standards (absent); W. A. Durgin, Department of Commerce and E. J. Mehren (Chairman), McGraw-Hill Company, Inc.

Illinois Water Works Men Meet at Urbana

Filter Operators Conference Precedes Regular Session—Treatment, Geology, Are Topics

A preponderance of papers on water treatment and analytical control characterized the program of the Illinois section of the American Water Works Association, March 19 and 20, at Urbana. The section meeting was preceded by the first two-day conference of filter plant operators in Illinois, called together by Harry F. Ferguson, chief sanitary engineer, State Board of Health. A committee was appointed representing the health board, the local section, the State Water Survey, the University of Illinois and the parent association, to foster and co-ordinate efforts toward an operator's school or conference next year.

Paul Hansen outlined the work of the national subcommittee, C-18, on filter sand analysis and recording. The report, which will be presented to the New York convention in May, is one of progress and information reviewing the sand grain size method of Allen Hazen, in use for thirty years, the Bureau of Standards proposal of sieves of standard mesh and the Abram's modulus-of-fineness method used in designating the fine aggregate for concrete. Additional examinations proposed include those for incrustation with lime, iron or manganese, physical observations of color, odor and shape, shrinkage tests, chemical analyses for certain mineral contents and organic material.

Other Topics Discussed

W. B. Bushnell, Champaign & Urbana Water Co., spoke of satisfactory use of chlorine up to 1 p.p.m. to reduce tastes and odors due to organic growths and subsequent demise. No chlorine tastes came through because of the absorption by the high iron content. Springfield also uses over-chlorination at times without trouble due to high iron content, said H. F. Ferguson. The composition of residual alum floc precipitating after passing filters is of carbonate formation not sulphate as ordinarily supposed according to numerous investigations of Dr. A. M. Buswell and W. U. Gallaher, reported by the latter in a paper on the subject. The rôle of colloids in boiler compounds and a comparison with the lime-soda external process was discussed chemically and commercially by E. M. Partridge, chemist, Paige & Jones Co., and A. S. Behrman, International Filter Co.

M. M. Leighton, chief state geologist, indicated that the ground waters of Illinois were gradually being depleted, which would force dependence on surface supplies. In consequence, his department is prepared to render assistance to engineers in the way of maps of available dam sites, the local geology of the site and foundation, and the interpretation of dwelling samples.

The effect of the new impounding reservoir on the filter plant operation at Decatur was given in a paper by W. E. Stanley, with Pearse, Greeley & Hansen and E. E. Ruthrauth, chief filter operator. A reduced turbidity has cut the required alum and the alkalinity fluctuation is reduced so that no soda is needed. Color has been increased as have the bacteria and the chlorine needed. With the exception of a short period a year ago when synura was encountered, tastes and odors have not bothered.

F. G. Gordon, of Maury & Gordon, presented an analysis of the fluctuations of cast-iron pipe prices for many years. G. C. Habermeyer spoke on the relative yield of wells in various strata. "The Editor's Mirror" was the subject of a brief talk by W. W. DeBerard western editor, *Engineering News-Record*.

The newly-elected officers are as follows: Dr. A. M. Buswell, chairman; L. R. Howson, vice-chairman; C. M. Roos, new trustee, H. E. Keeler, treasurer.

U. S. Particularizes Fraud Charge

An amended petition including a bill of particulars in the government's suit to recover $3,000,000 from A. Bentley & Sons Co., builders of Camp Sherman, Chillicothe, Ohio, was filed March 29 at Columbus. Specifications of the government's petition include charges that (1) 13,000,000 ft. of lumber were wasted; (2) inefficiency of and wrong use of labor caused a loss of $2,100,000; (3) conduct of the commissary cost the government $150,000; (4) $40,000 profits went to the contractor on material furnished by contractors; (5) the government was charged $13,000 more for truck hire than was paid for the trucks; and (6) the government lost $225,000 on sundry items.

Trinity River Diversion Approved

Diversion of the Trinity River in California from its own valley to that of the Sacramento River has been approved by the California Power Board, a board created at the instance of the Federal Power Commission. The report of this board, made up of D. C. Henny, of the Bureau of Reclamation, Major U. S. Grant 3d, E. W. Kramer of the Forest Service, and State Engineer McClure of California, states that the point of diversion should be just below the mouth of Stuart's Fork but that the present demand for power and irrigation does not warrant the diversion at this time.

New Building Height for St. Louis

Under an ordinance effective April 12, buildings in any part of St. Louis, Mo., may be carried to a height two and a half times the width of the street, and buildings of first-class construction may be carried to a height of 206 ft. or if they have frontage on three streets, to a height of 250 ft. The purpose of this ordinance, against the protest of the City Plan Commission of St. Louis, followed a ruling of the city counselor to the effect that the final decision of the Missouri Supreme Court upsetting a large part of the St. Louis zoning ordinance had left still in force the height regulations of that ordinance. Under the old zoning ordinance, the height limits varied from 150 ft. in the business districts to 45 ft. in outlying districts, with 10 per cent additional possible in special cases.

Random Lines

Why Editors Go Crazy

(Extract from a recently submitted manuscript)

A unique feature of the new viaduct is that the girders correspond to the curbstones on an ordinary street. Cross-beams from girder to girder support the road. Brackets extending out beyond the girders support the sidewalk in exactly the same manner that brackets support a shelf on your closet wall. This enables the viaduct, you might say, to devote itself entirely to the task of supporting its heavy traffic—its trucks and automobiles—without any wasted energy in supporting the light pedestrian traffic. It is a new and most excellent idea in bridge and viaduct design.

* * *

Doubling in Brass

Walter Arnold, for the past four years marshal and engineer of the village of Farmington has tendered his resignation to the council, to take effect April 1. Mr. Arnold intends to engage in business.—From *Michigan Contractor and Builder*.

* * *

Of Course Engineers Are Scientists

Distinguished men of science says "Science Service" have been found by Dean R. Brimhall, secretary of the Psychological Corporation, to be two hundred times more likely than other men to have distinguished wives. Scientists' wives are distinguished usually in science or literature.

* * *

Hungry Clients?

"We have many of our clients today to whom reference can be made, who run their engines sometimes for two months without a single stop for meals or for any purpose."—From an advertisement in the British Magazine "What's What in Engineering," circulated in Cuba.

* * *

Cruelty to Mushrooms

A sanitary engineer of the Illinois State Department of Health a while ago found that the chlorination of a contaminated quarry water used as a city supply practically cut off because it was thought the chlorinated water would kill some mushrooms. No real evidence was obtained that the chlorinated water did kill the mushrooms or that the dosage could be controlled to be safe for humans as well as mushrooms. The dose was simply cut off. After the inspector pointed out the liability for damages due to the criminal negligence of the officials if illness should result from the use of the contaminated supply the chlorine dosage was immediately increased. The incident, however, is hereby referred to the local humane society.

Engineering Societies

Calendar

Annual Meetings

NATIONAL CONFERENCE ON CITY PLANNING, New York City; Sixteenth Conference, Los Angeles, Calif., April 7-10, 1924.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Spring Meeting, Atlanta, Ga., April 9-12, 1924.

NATIONAL FIRE PROTECTION ASSOCIATION, Boston, Mass.; Annual Meeting, Atlantic City, N. J., May 13-15, 1924.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Convention, New York City, May 19-24, 1924.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago, Ill.; Annual Meeting, San Francisco, Calif., June 11-13, 1924.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Annual Convention, June 18-20, Pasadena, Calif.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia, Pa.; Annual Meeting, Atlantic City, N. J., June 23-28, 1924.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, University of Pittsburgh; Annual Meeting, Boulder, Colo., June 25-28.

The San Francisco Section of the American Society of Civil Engineers held a special meeting March 21 to hear two speakers. R. R. Woolley, hydraulic engineer of the U. S. Geological Survey, gave an illustrated talk on a trip down the Green River Canyon made by himself and party about two years ago to extend the line of surveys being made in the Colorado River and main tributaries. Homer M. Hadley, Seattle, district engineer of the Portland Cement Association, and who was sent by that Association to Japan after the earthquake, gave an illustrated talk on the effect of the earthquake on buildings.

Personal Notes

RAY JABLONSKY, for twelve years associate engineer in the office of the highway engineer at Clayton, Mo., has been appointed county surveyor and engineer for St. Louis County, succeeding William A. Elbring, who has resigned because of poor health.

EDWARD DIETRICH has been appointed city engineer of Tucson, Ariz., succeeding D. H. Atchley, resigned.

D. L. CALLICRATE, Portland, Ore., formerly engineer on Burbank Irrigation District 4, is now engaged as engineer for the Foster & Kleiser Co., whose business is outdoor advertising.

FRANK T. SHEETS has been appointed chief highway engineer in the Illinois Division of Highways to succeed Clifford Older who resigned recently to enter consulting engineering work. Mr. Sheets has been in Illinois state highway work since 1907 with the exception of the time spent in securing his engineering education at the University of Illinois. Prior to his appointment as superintendent of highways in 1920 he served in various engineering positions among them being assistant maintenance engineer, bridge engineer, and engineer of design. Mr. Sheets will, in addition to his duties as chief highway engineer, perform temporarily the duties of superintendent of highways.

RAGNER O. COMER, formerly principal assistant engineer of the Board of Commissioners of the Port of New Orleans, has resigned to accept an official position with the General Chemical Co., New York City. Mr. Comer went to the Dock Board of New Orleans about five years ago from the George W. Goethals Co.

L. G. CURTIS has been appointed chief engineer of the Baltimore & Ohio Chicago Terminal R.R., with offices in Grand Central Station, Chicago. Mr. Curtis has been assistant chief engineer of this road.

JOHN G. SULLIVAN, THEODORE KIPP, JR., and WILLIAM G. CHACE have associated themselves in a consulting and constructing engineering business at Winnipeg, Canada, known as SULLIVAN, KIPP & CHACE, LTD. Mr. Sullivan, who is a graduate of Cornell University, has followed the transportation business chiefly; in 1900 he became division engineer of construction for the Canadian Pacific Ry., in 1905 went to the Panama Canal work as assistant to chief engineer J. F. Stevens but two years later went back to the Canadian Pacific with which he was successively chief engineer of Eastern lines, chief engineer of Western lines, and chief engineer until 1918. Mr. Kipp is a native of Illinois, was early associated with the milling business and later in consulting mechanical engineering, successively as organizer of the Theodore Kipp Co., Ltd., and Kipp-Kelly, Ltd. Mr. Chace is a University of Toronto graduate, recently president of the Canada Lock Joint Pipe Co., and previously engaged in hydroelectric projects in and near Winnipeg and for seven years chief engineer for the Greater Winnipeg water district. The new firm's headquarters are in the Nanton Bldg., Winnipeg.

H. E. BILGER, formerly district engineer and road engineer, Illinois State Highway Department, has accepted the position of professor of highway engineering at the Agricultural and Mechanical College of Texas, College Station, Texas. Mr. Bilger was eleven years in highway work, three years previous to that in railroad engineering. For several years after leaving the Illinois department he was engaged in designing and marketing steel forms for concrete culverts.

G. C. CLEVELAND, formerly chief engineer, New York Central Lines West of Buffalo, has, upon reaching his 70th year, been appointed consulting engineer with headquarters at Cleveland, Ohio. R. O. ROTE, formerly assistant chief engineer, has been appointed chief engineer vice Mr. Cleveland, and the position of assistant chief engineer has been abolished. CHARLES YODER, formerly engineer of track, has been appointed engineer maintenance-of-way, with headquarters at Cleveland, and L. B. HOLT has been appointed engineer of track vice Mr. Yoder.

MAJOR JOHN C. GOTWALS, Corps of Engineers, U. S. Army, has been released from further service under the Department of the Interior on the government railroad in Alaska. Major Gotwals had served as chief engineer of the Alaska Road Commission since 1920 and as chief engineer and vice-chairman of the Alaska R.R. since March, 1923.

Obituary

JOHN A. OCKERSON, St. Louis, Mo., member of the U. S. Mississippi River Commission since 1898, died March 22 at his home in St. Louis, from a stroke of paralysis suffered at his office March 14. Mr. Ockerson was 76 years of age, having been born in Sweden in 1848. A more extended biography will appear in these columns next week.

WILLIAM H. MAW, senior joint editor of *Engineering* (London), died March 19 at his home in Kensington, England, aged 85 years. Mr. Maw had been associated with *Engineering* since 1865, and for many years also carried on a practice as a consulting engineer. He was a past-president of the Institution of Civil Engineers and of the Institution of Mechanical Engineers, and was the author of important engineering works. He was a member of the committee responsible for the foundation of the British Engineering Standards Association in 1901.

JAMES HUNTER DUTHIE, of Toronto, Canada, died March 20 after a long illness, at the age of 62 years. Mr. Duthie was one of the pioneers in the movement for deepening the waterways from the Great Lakes to the Atlantic. He was secretary of the National Waterways Association of Canada until that organization became merged in the Canadian National Waterways and Power Association. He had resided in Detroit for a ten-year period.

N. HANSON GREENE, civil engineer, Montreal, Que., died in that city March 25. He had practiced in civil engineering and land surveying for over fifty years in Montreal and Ontario.

E. B. CUSHING, retired, chief engineer maintenance-of-way of the Texas and Louisiana Lines of the Southern Pacific System, died at Houston, Tex., recently. He was born at Houston, Nov. 22, 1862, and entered railway service in 1879. Mr. Cushing was appointed engineer, maintenance-of-way of the Texas lines of the Southern Pacific in April, 1901, general superintendent of the Louisiana lines in 1904, and chief engineer maintenance-of-way in 1917, which position he held until his retirement in September, 1920.

From the Manufacturer's Point of View

A Point of Contact Between Maker and User of Construction Equipment and Materials

Production Difficulties in Manufacturing

How the Equipment Distributor and User Can Help in Ordering Standard, Instead of Special Machines

By J. T. Frost
Clyde Iron Works, Duluth, Minn.

Slightly condensed from a paper presented to the annual meeting in Milwaukee of the Associated Equipment Distributors.

ECONOMICAL production must have for its foundation standard practice. Therefore, standard raw materials should be selected and adapted as far as they are applicable to the article to be produced, then standard engineering practised, standard patterns made, standard jigs and templates manufactured, and standard labor employed. Employees become accustomed to handling standard parts and assembling standard units. These are the first steps in standardization. Thus far production readily lends itself to economy.

Specializing greatly interferes with economical production as it eliminates standard practice, quantity production, and interchangeability of parts, thereby increasing production cost and overhead. Most manufacturers look on inquiries embodying special features with disfavor, but they always welcome constructive ideas which can be applied as permanent improvements to their product. If the changes involved will better adapt the product to the full requirements of the entire purchasing field, the manufacturer will keep his product standardized to meet this progress.

Inquiries for Special Machines

Salesmen and sales organizations should familiarize themselves with their manufacturer's complete standard lines and his facilities for production, thereby placing themselves in a better position to consider intelligently inquiries embodying special characteristics. Inquiries easily and unintentionally lead to specialization, if not carefully considered, because the customer gets his information from obsolete literature, not knowing that the manufacturer has a later model standard product which will meet all their requirements; from circulars illustrating only one type of machine; from observations of neighboring installations; from a single advertisement. It is not logical to suppose that all these customers will describe some standard unit, but it is reasonable to believe that the live manufacturer has a standard product which will meet all their requirements.

It is surprising how many of these inquiries reach the sales manager's desk from sales organizations requesting special quotations covering them. I am sure 50 per cent of them would be eliminated if the idea of applying a standard product were considered. Considerable business would be saved which is now lost because a live-wire competitor gets on the job, applies the proper standard machine, and secures the order before correspondence can be exchanged.

Every inquiry received represents a certain investment in advertising. Therefore, every opportunity mishandled or neglected, which results in loss of business, increases overhead. Every special estimate prepared and quotation submitted represents an additional investment. If orders are lost on account of improper consideration and investigation overhead is doubled and production cost increased.

Raw Materials and Labor

Let us now consider the commodities entering into production: These include pig iron, boiler plate, shafting, etc., to which labor is added in the first steps toward production. The materials mentioned are more or less staple, being largely governed by supply and demand. Labor, however, must be supplied with proper working conditions, receive certain humane consideration not applicable to the other commodities if steady and satisfied employees are to be kept at work. The manufacturer who does not consider his labor carefully is confronted with a heavy turnover which means decreased production, increased costs, and greater overhead.

Then we have the manufactured items, such as electrical equipment, gasoline motors, etc., manufactured outside of the manufacturer's plant, to which additional labor must be applied to assemble into a finished product. This is the second step in production. Both these steps represent an absolute cash outlay on the part of the manufacturer. Cash business is economical business and economy is the hub of the wheel around which production turns. Over-production, however, must not be allowed to develop, for over-production means borrowing money on which interest must be paid, again increasing overhead.

Overhead

Let us now consider overhead, as it is of vital importance to production. Every production man has an overhead chip on his shoulder, for its application to productive labor and material is a millstone around the neck of economical production. The following suggestions for reducing overhead are given:

Do not ask the manufacturer to consign you goods which represent a cash outlay on his part and thereby greatly increase his invested capital.

Do not cut prices without being willing to assume your full share of the cut.

Do not divide your sales efforts by handling two or three competitive lines.

Do not expect the manufacturer to assume responsibilities you would not assume yourself.

Protect your manufacturer's interests as you protect your own and a great many of the production difficulties encountered in manufacturing will be eliminated.

Motor Vehicle Registration Shows Total of 15,092,177

Gain of 187,000 in 1923—Receipts of $188,900,000 for Licenses and $36,000,000 for Gas Tax

A CONTINUED demand for road-building and maintenance equipment and materials is indicated by the motor vehicle registration figures for the United States just issued by the Bureau of Public Roads. On Dec. 31, 1923, there were 15,092,177 motor vehicles in use in the United States, representing an increase of 2,853,802 vehicles over the number registered in 1922. This increase, which is 187,000 registrations greater than the gain in any other year means that the public demand for road improvement, already strong, will be strengthened, and a more general use of the road, particularly in a business and commercial way, will result. As indicative of the commercial trend motor truck registrations now total over 1,500,000, the hundred-thousand mark having been

MOTOR VEHICLE REGISTRATIONS, REVENUE AND GASOLINE TAXES FOR THE YEAR 1923

States	Total Registration Cars and Motor Trucks	Receipts from Registration Fees Licenses and Permits	Receipts from Gasoline Tax (2)
Ala.	126,642	$1,541,017.56	$1,133,085.49
Ariz.	49,175	281,670.75	474,123.04
Ark.	113,300	1,435,090.00	1,219,198.75
Calif	1,100,283	10,608,544.00	2,518,893.00
Colo.	188,956	1,126,218.55	846,353.12
Conn.	181,748	4,329,432.16	880,222.70
Del.	29,977	516,209.00	88,579.28
D. of C	74,811	357,918.00	
Fla.	151,990	1,963,065.99	1,641,042.25
Ga.	173,889	2,156,406.08	1,502,503.49
Idaho	62,379	914,014.58	396,487.18
Ill.	969,331	9,653,796.04	
Ind.	583,342	3,693,715.00	2,906,428.25
Iowa	571,061	8,827,062.99	
Kansas	375,594	3,435,606.00	
Ky.	198,377	2,678,732.89	680,435.30
La.	136,622	2,191,240.81	754,437.83
Maine	108,609	1,660,268.17	286,076.97
Md.	169,351	3,536,955.20	688,304.02
Mass.	481,150	6,989,633.25	
Mich.	730,658	10,500,786.05	
Minn.	448,187	7,316,772.03	
Miss.	104,286	1,077,616.22	467,855.53
Mo.	476,598	4,016,383.60	
Mont.	73,828	729,621.50	441,249.10
Neb.	286,053	3,353,175.32	
Nev.	15,699	153,988.10	115,843.24
N. H.	59,604	1,571,326.96	163,064.64
N. J.	430,958	7,653,780.37	
N. M.	32,032	296,000.00	165,000.00
N. Y.	1,204,213	19,862,411.52	
N.C.(1)	(1)246,812	(1)3,728,044.72	2,909,904.74
N. D.	109,266	760,852.45	461,081.71
Ohio	1,069,100	9,662,370.29	
Okla.	307,000	3,217,770.84	599,000.00
Ore.	165,962	4,069,609.40	1,958,141.37
Penn.	1,043,770	15,844,303.80	5,491,522.66
R. I.	76,312	1,286,659.47	
S. C.	127,467	902,608.69	1,511,452.56
S. D.	131,700	1,130,959.27	624,692.44
Tenn.	173,365	2,049,653.27	812,356.68
Texas	688,233	5,441,508.59	1,215,623.36
Utah	59,525	430,104.72	404,085.81
Vt.	52,776	938,860.30	168,172.81
Va.	218,896	3,200,161.66	1,556,920.99
Wash.	258,264	3,898,597.77	1,225,149.66
W. Va.	157,924	2,608,508.37	366,490.00
Wis.	457,271	4,958,933.55	
Wyo.	39,831	414,096.39	140,161.62
Totals	15,092,177	$188,970,992.24	$36,813,939.61

(1) For the first six months of the registration year which begins on July 1.
(2) In several States gasoline tax in effect only part of the year.

(*Concluded from Second Column*)

passed in New York, Ohio and Illinois and the fifty-thousand mark in Indiana, Massachusetts, Michigan, New Jersey and Pennsylvania. In each of the states of California, New York, Ohio, and Pennylvania the registrations exceed 1,000,000 motor vehicles.

RECEIPTS SHOW GAIN

While the owners of motor vehicles are insistent in their demand for more and better roads, the statistics show, the Bureau of Public Roads points out, that they are bearing a very considerable share of the cost of the roads, especially of the cost of maintenance of the state highways. Gross receipts from registration fees, together with the licenses of drivers, chauffeurs, etc., amounted to $188,900,000, or 23 times the amount derived from this source in 1913. During the same period motor vehicle registrations have increased 12 times.

In 35 states a gasoline tax ranging from 1 to 4c. per gallon is imposed. Revenue from this source, amounting to $36,300,000, is spent largely for highway purposes. This revenue will be materially increased in 1924, since in many states such taxes have been in effect only a few months.

Past experience leads the Bureau to predict that registrations will continue to increase materially during the present year and that road construction will continue at about the same rate which has been maintained for the past two years. Much of this construction will be on roads never before improved.

Advises Substitution of 21- for 20- and 22-In. Sewer Pipe

Committee C-4, Clay and Cement Sewer Pipe, American Society for Testing Materials, voted on March 4 that the committee "deems it advisable to discontinue the use of the 20- and 22-in. sewer pipe and to substitute therefore the 21-in. sewer pipe."

Paving Brick Orders Increase

That highway departments and municipalities are awarding contracts for street and highway paving early in the season, is indicated by the sharp increase in unfilled orders for vitrified paving brick during the month of February. The February statistical report submitted to the Department of Commerce by the National Paving Brick Manufacturers Association, shows an increase in unfilled orders in the industry for No. 1 pavers of 10,000,000 to a total of 86,691,000. Unfilled orders in No. 2 and off-grade pavers increased 7½ million to a total of 19,884,000.

An increase in production during February of 1,200,000 brick is also shown. The stock on hand is in excess of the unfilled orders. Shipments during February showed a falling off of approximately 3,000,000 to a total of 10,100,000 due to the unseasonable weather prevailing over practically all sections of the country. The largest shipments were made into the state of Ohio during this month. Shipments to the states of Texas, Kansas, Oklahoma and Illinois follow in the order named.

Business Notes

NORTHWEST ENGINEERING CO. announces the appointment of Roy G. Owens as its Chicago agent, with offices in the Steger Building. Mr. Owens has been in the construction industry all his life, his first business experience being in general and builders' hardware lines. In 1910 he joined the sales force of the Texas Portland Cement Co., and, after a year with that organization, went with the Wiley Chute Co., of which he later became proprietor. This company manufactured concrete distributing apparatus and Mr. Owens' connection with it continued from 1912 to 1917. In 1916 he became general sales manager of the Milwaukee Concrete Mixer Co., at the same time directing the interests of his own organization. In 1917 came the consolidation of the Milwaukee company with the Lakewood Engineering Co., with Mr. Owens in charge of sales.

MITCHELL-TAPPEN CO., New York, announces the appointment of the Steel Specialties Co., of Atlanta, Ga., represented by G. M. Sykes, and Strafford R. Hewitt, as its representatives for the sale of Mitco interlocked steel gratings and stair treads in a considerable portion of the south.

LAKEWOOD ENGINEERING CO., Cleveland, announces that it has appointed Edelen & Boyer Co., 236 North 23rd St., Philadelphia, Pa., as its direct representative on general construction and paving equipment in the Philadelphia territory. The personnel of the Lakewood office has joined the Edelen & Boyer forces, and warehouse facilities assure prompt repair service and shipment from stock on a variety of units.

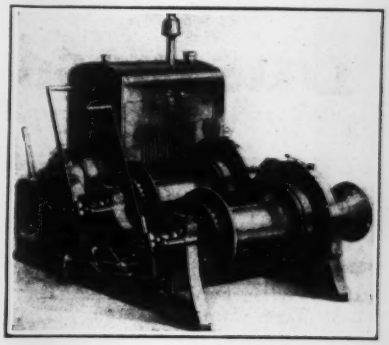
LANE-BOWLER CO., Memphis, Tenn., water supply contractors and manufacturers of deep-well turbine pumps, has established a branch known as the Lane-Bowler Michigan Co., Dime Bank Bldg., Detroit, Mich., under the direction of G. L. Harmon and R. E. Garrett.

MCMYLER-INTERSTATE CO., Cleveland, Ohio, announces the opening of a new branch office at 619 Genesee Building, Buffalo, N. Y., in charge of J. E. McFate.

Equipment and Materials

New Gasoline Hoist

The new 15-hp. gasoline "Handihoist" manufactured by the Mead-Morrison Manufacturing Co., Boston, is now in use on a number of contracting jobs in the East. It is a single-drum machine, made double-drum by bolting on a second unit when desired. The hoist is equipped with cut gears, asbestos-lined frictions and brakes. It has bronze-bushed drums, machined all over. Power is supplied from a four-cylinder, heavy-duty LeRoi



engine. The hoist, according to its manufacturer, is adapted to scraper, derrick, elevator and general hoisting work.

To Simplify Tank Sizes

Manufacturers of tanks, and manufacturers of equipment in which tanks are used, were invited to meet in a series of conferences under the auspices of the Division of Simplified Practice of the Department of Commerce, Washington, D. C., March 11, 12, 13 and 14 to eliminate seldom-used sizes and varieties. More than 150 manufacturing representatives from 24 states have been invited, as well as delegates from the National Board of Fire Underwriters, American Institute of Architects, American Society of Sanitary Engineering and other technical groups and from city fire departments. Distributors and consumers will be present.

The conferences will deal with hot-water storage tanks, cold-water storage tanks, pneumatic tanks, gasoline underground storage tanks, distillate and fuel oil storage tanks, and air receivers. The meeting will be a sequel to conferences held during January. At that time manufacturers of hot-water storage tanks agreed on tentative recommendations reducing their products to 5 sizes and 2 working pressures. Manufacturers of pneumatic tanks at that time also were in favor of a reduction of their products to 9 sizes and one working pressure. These developments resulted in a request to the Division of Simplified Practice for assistance in bringing about simplification of cold-water storage tanks, gasoline storage tanks, fuel oil and distillate tanks, storage tanks for oil heating systems, and air receivers.

Publications from the Construction Industry

Industrial Construction—CHARLES T. MAIN, engineer, Boston, Mass., has just published an illustrated pamphlet describing typical installations of dye houses for textile plants. The information is conveyed principally by means of pictures, the text being confined to notes on the general problems involved in a number of typical installations. Particular stress is placed on layouts which insure economy of operation and proper atmospheric conditions.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

Why Costs Should Not Go Higher for a While

Present Contract Volume Less Than Last Year—Materials Men Try To Check Price Rise

During the first quarter of this year construction cost, as reflected by *Engineering News-Record's* Index Number, has averaged 12 per cent above that of the first three months of 1923. During this period contracts were let to the value of $500,081,000, against $506,690,000 in the corresponding period of 1924. But, while the money involved in this year's awards compares favorably with last year's, the actual physical volume is 11 per cent smaller.

Just about a year ago Secretary Hoover advised the President to delay the federal construction program, so that materials producers might catch up on their orders. Another reason was that labor in the building trades was at full employment. Construction cost had been mounting steadily for a year and then registered only 25 per cent under the 1920 peak.

Talk of a buyers' strike and considerable actual curtailment of building, continued until early in July, 1923. The movement reached its height on Apr. 30, when a conference of contractors, architects and bankers strove to find a way to check rising costs.

At that time there were rumors and definite warnings of a depression coming along. In fact, it is probable that but for the general publicity given the situation, the depression might easily have materialized. As it was, on July 12, *Engineering News-Record's* Construction Barometer was able to say, "The promised business depression may yet come, but the heed paid to the warnings seems to have postponed it."

Thus far this year the situation is less critical than last. Manufacturers and dealers recognize that prices are high—in general, higher than a year ago,—and are making strong efforts to keep them from going higher. They still remember the dull days of 1921, following the peak prices of 1920. Experience with last year's rising costs and threatened buyers' strikes should prove valuable in the attempt to control the present situation.

Centralized Buying of Road Materials Saves $3,000,000

That wholesale purchasing of road building materials by states, is saving taxpayers' money has been demonstrated by the records of several states that have adopted that method, according to B. H. Piepmeier, engineer of the Missouri State Highway Department.

It is estimated by Mr. Piepmeier that centralized buying in Missouri has saved the taxpayers more than $3.000.000. He also contends that uniform buying saves time and avoids red tape and duplication

Regarding the plan now in use in Missouri, Michigan, North Carolina, Illinois, Wisconsin, Connecticut, Indiana and Delaware, Mr. Piepmeier said: "It could be tried with success in other states. The plan secures a steady supply of cement, speeds up delivery and reduces the expense to the taxpayers. North Carolina has saved $350,000 in three years in this way. The contractors are better pleased too on account of competition with privately operated plants. Because of the great expense in getting started it was decided it would be inadvisable for the state to manufacture; so that commercial plants were enlarged. In my opinion a Government operated plant cannot be so efficiently operated as a privately owned one."

Utah to Have 126.2 Mi. of Continuous Concrete Highway

Highways in the United States of 23-mi. or longer, having a continuous concrete pavement are shown in the accompanying table.

Wisconsin is in the lead with a 93-mi. strip, Minnesota, Iowa and California following in the order named.

MILES OF CONTINUOUS CONCRETE PAVEMENT

State	Road	Length, Miles
Wisconsin	Troy Center through Milwaukee Co. to Fond du Lac	93
Minnesota	Anoka to Belle Prairie	83
Iowa	Charles City to Algona	78
California	Yuba City to Chico	60
Delaware	Lewes to Dover	60
California	Chico to Red Bluff	60
Minnesota	Duluth to Eveleth	56
Minnesota	Westmoreland to Indio	54
Florida	Jacksonville to Lake City	43
Colorado	Denver to Greeley	35
Arizona	Phoenix to Buckeye	33
California	Edom to Banning	30
Utah	Wellsville to Cross Roads	25
Utah	Pleasant Grove to Payson	25
Maine	Portland to Lewiston	23

Utah, however, will hold the record when the paving contract between Payson and the Juab County line, and the Riverdale viaduct are completed. There will then be a continuous paved strip of 151.7-mi. running from a point west of Brigham in Box Elder County through Weber, Davis, Salt Lake and Utah Counties to Nephi, 126.2-mi. of which will be concrete with 25.2 mi. of bituminous types.

Large Contracts Let During Week

Among the week's announcements of contracts awarded in Construction News, pp. 187 to 201, are the following:

Office, New York, N. Y., J. Tishman & Sons, Inc., $5,000,000.

Hospital, Cleveland, O., to A. Dall Constr. Co., $3,225,000.

Additional water supply, Kansas City, Mo., to Tibbets & Pleasant, Tulsa, Okla., $1,395,412; Byrne Bros. Constr. Co., Chicago, Ill., $1,873,295.

Paving, St. Petersburg, Fla., to Georgia Eng. Co., August, Ga., $1,500,000.

Trenching, Santa Monica, Calif., to C. Fisher, Los Angeles, $1,476,522.

Theatre, New York, N. Y., Chanin Constr. Co., $1,150,000.

Club, Indianapolis, Ind., to W. P. Jungclaus, $1,000,000.

Office, Philadelphia, Pa., to J. M. Stewart Co., New York City, $1,000,000.

Bridge, Springfield, Mass., to American Bridge Co., New York City, $520,371; to P. T. Cox Contg. Co., New York City, $353,818.

Power Plant, Bluefield, W. Va., Viele, Blackwell & Buck, New York City, engrs.

Foreign Projects of Interest to Americans

A number of foreign construction projects which should be of interest to American engineers, contractors and manufacturers have been reported by the United States Department of Commerce. They are noted here, further information being available at the Bureau of Foreign and Domestic Commerce or its district co-operative offices when a reference number is given.

Harbor improvement and dock construction under way in India. This work should create a market for engineering machinery, motors, pumps, concrete mixers, light excavators, cranes, etc., for the next 10 years. Reference No. 14823.

Road contract awarded in Panama for section about 50 kilometers southwest of Panama for road between the San Carlos and Espino Rivers. Reference No. 121429.

Local steel and iron manufacture promoted by Brazil. Government authorizes the establishment of three plants for the manufacture of iron and steel. Reference No. 122216.

Water-works and sewerage system in Brazil. The president of a State in Brazil has signed a contract for the construction of a waterworks and sewage system. This will give rise to water meters, household connections, reconstruction of roads, chemical disposal plant. Reference No. 122722.

Skating rink and swimming pools planned for Nagoya, Japan. Reference No. 123189.

New construction authorized by Brazilian government. This includes purchasing of dredging apparatus, dredging, construction and exploitation of a quay in the city of Cabo Frio for embarkation and disembarkation. Reference No. 15335.

Paving for Mexican city streets The necessity of paving the principal streets of a certain Mexican city has been recognized. A study is being made of the purchasing of rock crushers, other machinery and road building materials. Reference No. 125,295.

March Contracts Gain Three Per Cent Over Preceding Month

Drop of 11 Per Cent In Money Value and 14 Per Cent In Actual Physical Volume Compared With Year Ago

The total value of contracts awarded on large engineering construction projects, as published in *Engineering News-Record* during March, reached $170,313,000 as against $165,046,000 for the preceding month. Compared with a year ago March, 1924, construction shows a drop of over 11 per cent in money value and 14 per cent in actual physical volume.

Minimum costs observed in the Construction News section on each class of construction are as follows: Waterworks and excavations, $15,000; other public works, $25,000; industrial construction, $40,000 and commercial buildings, $150,000.

The March gain was due principally to increased lettings of contracts for sewers, bridges, streets, roads and Federal Government work.

Construction was more active during March than for the month preceding, in New England, the Middle West and the states immediately west of the Mississippi and fell off slightly in the South, the Middle Atlantic states and the Far West.

The actual physical volume of construction represented by March contracts is 14 per cent under the same month in 1923; 17 per cent below March, 1922; 91 per cent above the corresponding period in 1921 and 25 per cent greater than March, 1920.

Among the large projects awarded during March were the following: A club and hotel building, Detroit, Mich., $3,500,000; completion of Wanaque, N. J., reservoir dam, $3,319,000; bridge over Delaware River at Philadelphia, Pa., $2,888,000; hotel at York, Pa., $2,500,000; office building, Boston, Mass., $2,500,000; hotel, Albany, N. Y., $2,500,000; railway from Summit to Hicks, Calif., $2,500,000 and a power plant at Tecumseh, Kan., $2,225,000.

Business Briefs

Call money ranged from 5@5½ per cent, March 31.

Time money slower but firmer at 4½ @4¾ per cent for all loans.

Commercial paper rates were 4½@4¾ per cent for all names.

Foreign exchange:

	This Week	Last Week	Year Ago
Sterling	$4.29 11/16	$4.29⅜	$4.67⅜
Franc	0.0551	0.0535½	0.0665⅜
Lira	0.0437½	0.0430½	0.0497½

Bids Wanted on Big Jobs

Among the projects on which bids are either asked or will soon be called for in Construction News, pp. 187 to 201, are the following:

Hotel, Boston, Mass., for Statler Hotel Co., $4,000,000.

Paper Mill, Ft. William, Ont., Great Lakes Paper Co., $2,000,000.

Railway, Oklahoma, Beaver, Meade & Englewood R.R. Co., $559,500.

Engineering News-Record Construction Cost Index Number

April, 1924	221.60
March, 1924	224.70
April, 1923	213.50
Peak, June, 1920	273.80
1913	100.00

Jan., 1923	191.70	Aug.	221.50
Feb.	197.40	Sept.	221.50
Mar.	205.25	Oct.	220.30
Apr.	213.50	Nov.	220.90
May	216.70	Dec.	217.30
June	220.70	Jan., 1924	217.90
July	222.10	Feb.	220.30

Engineering News-Record's Construction Cost Index Number dropped 3.1 points since last month, owing to lower steel and lumber prices. The average rate for common labor is 55c. per hr., against 54c., which rate remained in effect from June 1, 1923, to Mar. 1, 1924. Thus, general construction cost is 4 per cent higher than one year ago and 19 per cent under the peak; it is 122 per cent above the 1913 level.

Engineering News-Record Construction Volume Index Number

Monthly

March, 1924	(*4 issues of E. N.-R.*)	134
February, 1924	(*4 issues of E. N.-R.*)	128
March, 1923	(*5 issues of E. N.-R.*)	195

Yearly

1923 (entire year)	135
1922 (entire year)	130
1921 (entire year)	88
1920 (entire year)	91
1919 (entire year)	91
1913 (entire year)	100

Engineering News-Record's Construction Volume Index Number is 134 for the month of March, and 135 for the whole of 1923, as against 100 for 1913. This means that the actual volume of construction in 1923 (not the mere money-value of the contracts let that year) is 35 per cent above the volume of construction for 1913. Our monthly volume number, 134 for March, 1924, contains the increment of construction, and indicates the rate at which contracts are being let as compared with 1913 awards.

VALUE OF CONTRACTS LET IN THE UNITED STATES AND CANADA DURING MARCH, 1924

	New England	Middle Atlantic	Southern	Middle West	West of Mississippi	West	Total United States	Canada	Grand Total
Waterworks	$75,000	$776,000	$386,000	$838,000	$1,409,000	$612,000	$4,096,000	.....	$4,096,000
Sewers	.....	1,293,000	497,000	1,446,000	393,000	180,000	3,809,000	152,000	3,961,000
Bridges	35,000	3,894,000	830,000	83,000	3,552,000	356,000	8,750,000	418,000	9,168,000
Excavation, drainage, etc.	.....	40,000	105,000	86,000	401,000	550,000	1,182,000	.....	1,182,000
Streets and roads	1,389,000	6,687,000	7,367,000	11,244,000	9,686,000	4,389,000	40,762,000	633,000	41,395,000
Industrial works	855,000	3,452,000	2,050,000	2,535,000	3,066,000	644,000	12,602,000	400,000	13,002,000
Buildings	6,700,000	32,593,000	5,792,000	21,232,000	8,889,000	4,313,000	79,519,000	325,000	79,844,000
Federal government	149,000	26,000	1,546,000	75,000	304,000	915,000	3,015,000	.....	3,015,000
Unclassified	300,000	3,847,000	400,000	564,000	1,117,000	6,272,000	12,500,000	2,150,000	14,650,000
Total	$9,503,000	$52,608,000	$18,973,000	$38,103,000	$28,817,000	$18,231,000	$166,235,000	$4,078,000	$170,313,000

Labor Rates and Conditions Throughout the Country

The trend of building trades wages is upward in most of the large industrial centers. In Chicago, Cincinnati, St. Louis, Pittsburgh, Kansas City and New Orleans wage increases have recently been granted or are now under serious consideration.

St. Louis building laborers went on strike Mar. 1, for a wage advance of 20c. per hr. This city pays the highest building trades wages in the world. An agreement, however, has recently been effected between workers and employers, granting a rise of 10c. per hr. The St. Louis situation is being keenly watched by builders throughout the country.

New York's two-year agreement has stabilized conditions there. Bricklayers and plasterers continue to receive bonuses of $1 to $2 per day. It is noteworthy that a recent Supreme Court decision obligates builders, who once grant bonuses on a given operation, to continue such payments until the completion of the job.

As in former years, the only skilled trades in which an acute shortage may be said to exist are the bricklayers and plasterers.

CURRENT BUILDING TRADES WAGE RATES PER HOUR
(Higher rates indicated by +, decreases by —)

Cities	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor
Atlanta	$1.12½	$0.70	$0.70	$0.50	.....	$0.75	$0.25@.30
Baltimore	1.50	.90@1.00	1.00@1.12½	1.00	$0.65	1.12½	.40
Birmingham	1.00	1.00	.50@1.00	.30@.40	.....	1.00	.30@.40
Boston	1.25	1.00@1.10	1.25@1.35	.82½	1.05	1.12½	.00@.75
Cincinnati	1.50	1.15	1.15	.90	1.15	1.15	.52½
Chicago	1.25	1.15	1.00@1.25	.88¾	1.10	1.25	.82½
Cleveland	+1.50	1.25	1.25	.87½	1.00	+1.37½	.87½
Dallas	1.50	1.00	1.00	.40@.75	.87½	1.00	.30@.50
Denver	+1.62½	1.12½	1.12½@1.18¾	.75@.81¼	1.00	1.15⅝	.35@.55
Detroit	1.12½	.80	.80@.90	.50@.60	1.00	.60@.80	.50
Kansas City	1.37½	1.12½	1.00@1.25	+.90	1.00	+1.15	.40@.70
Los Angeles	1.25	.100	1.00	.62½	.....	1.00	.50
Minneapolis	1.12½	.87½	.87½	.71½	.....	.87½	+.50@.55
Montreal	.90	.65	.50	.35	.50	.65	.25
New Orleans	1.25	.90	1.00	.65	.80	1.00	.35@.40
New York	1.50	1.31¼	1.50	1.00	1.00	1.25	.62½@.75
Philadelphia	1.50	1.12½	1.02½@1.13½	.70@1.00	1.00	1.10@1.12½	.45@.50
Pittsburgh	1.40	1.20	1.12½	1.00	.....	1.25	.70
St. Louis	1.75	1.50@1.60	1.50@1.67½	1.15@1.25	1.25	1.25@1.50	—.45@1.10
San Francisco	1.25	1.00	1.00	.81¼	1.00	1.12½	.50@.55
Seattle	1.25	1.00	1.00@1.12½	.93¾	1.00@1.12½	1.12½	.62½

The average rate paid common laborers (pick and shovel men) in construction operations continues to be 55c. per hr. for the entire country. The rate stood at 54c. per hr. from July, 1923 to March 1924, at which time it advanced to the present level. Local conditions as reported to *Engineering News-Record* follow:

Atlanta — Labor plentiful in all classes.

Baltimore—Industrial conditions normal.

Boston—Enough building trades mechanics.

Dallas—Slight surplus of unskilled and semi-skilled labor. Bricklayers and carpenters in good demand; all other skilled crafts employed.

Denver — Bricklayers advanced to $1.62½ per hr., from $1.50.

Detroit—Supply in all trades normal with no shortage of any class. Numerous construction projects now under way will furnish employment for large number of men.

Kansas City—Structural iron workers now receiving $1.15 per hr., demand advance to $1.25. Some unemployment reported; demand principally for bricklayers and plasterers.

Los Angeles—Construction ahead of this time last year. Labor conditions good; plenty of men.

Minneapolis—No labor troubles evident. "Open shop" conditions prevail in this city. Employers expect to observe same wage scale as in 1923.

Montreal — Ample supply of all trades.

New Orleans—Labor ample to meet all demands.

Pittsburgh—Strike of sheet metal workers settled. Wages in this craft fixed at $10.50 per day until June 1, when $11 will become effective. Structural iron workers, hoisting engineers and plasterers are still on strike.

San Francisco—Still a small amount of unemployment in the building trades.

Monthly Prices of Construction Materials

Ups and Downs of the Market

Pig-Iron—Improvement in pig-iron inquiries; buying mostly in small tonnages. No. 2 f'd'y iron $22.50@$23 per ton, Birmingham, against $25 one year ago. Very little foreign iron coming in owing to the high price of the imported product.

Railway Supplies — Track material quiet; very slight improvement in demand for light rails. Minimum on standard spikes, $3 per 100 lb., Pittsburgh, against $3.05, one month ago.

Pipe—Entire pipe discount list continues firm. Demand for standard pipe more active; butt-weld pipe market slower. All cast-iron pipe mills busy.

Road and Paving Materials—Bulk asphalt up $1 in Minneapolis and $2 per ton in New York, during month; slight drop in Boston. Granite paving blocks higher in New York and Kansas City; slight drop in Philadelphia and St. Louis. Wood blocks lower in St. Louis and New Orleans.

Sand, Gravel and Crushed Stone—Sand prices down in six out of nineteen cities reporting regularly to *Engineering News-Record*. Considerable fluctuation in gravel and brushed stone prices, with advances about balancing declines.

Lime—Prices advanced in Kansas City, St. Louis and Detroit. Exception is offered to the Western cities, however, in a drop of 10c. per bbl. in brown lime at Minneapolis. Lump finishing lime down 30c. per bbl. and hydrated, 50c. per ton in Boston, during month.

Cement—Of thirty cities reporting regularly to *Engineering News-Record*, six registered advances and two, declines since last month. Boston reported a rise of 2c.; Indianapolis, Peoria, Davenport and Cincinnati, 10c. and Kansas City, 20c. per bbl. Cleveland dropped 2c. and Birmingham, 15c. per bbl.

Steel—Railroad material and structural steel form the bulk of current buying. Reinforcing bar market dull; price still $2.40 per 100 lb. at mill. Structural quotations show wide range, with present level slightly below month ago. Plates are quoted at $2.25@$2.50, shapes at $2.30@$2.50 per 100 lb. at Pittsburgh mill.

Brick and Hollow Tile—General trend of both materials downward. Dallas, however, quotes common brick at $13.60 as against $11.60 per M, last month.

Lumber—Shipments and new business slower; production increasing gradually. Pine down in New York, Minneapolis, Birmingham and St. Louis; rises reported in New Orleans and Dallas. Douglas fir declined in Minneapolis and advanced $5 per M. ft. in Los Angeles since Mar. 6. Hemlock tending downward; no change in spruce. Flooring, finishing and dimension lumber demand good; boards, timbers and railroad material slower.

Explosives—Kansas City was the only one of eighteen cities reporting regularly to *Engineering News-Record* to show change in dynamite prices during month; the change involved advances ranging from ¼c. to ⅜c. per lb. Revision of electric blasting caps' prices became effective Mar. 15.

Scrap—Dealers' stocks are heavy. Stove plate, No. 1 machinery cast and heavy melting steel down $1 per ton f.o.b. New York since Mar. 6.

Linseed Oil—Fluctuations continue in the linseed oil market with advances offsetting declines. The price f.o.b. New York is 2c. per gal. under month ago.

Price advances since last month are indicated by **heavy type**; declines by *italics*

PIG IRON—Per Gross Ton—Quotations compiled by The Matthew Addy Co.:

	Apr. 3	One Year Ago
CINCINNATI		
No. 2 Southern (silicon 2.25 @ 2.75)	$25.05	$31.55
Northern Basic	24.00	31.27
Southern Ohio No. 2 (silicon 1.75 @ 2.25)	24.00	33.27
NEW YORK, tidewater delivery		
Southern No. 2 (silicon 2.25 @ 2.75)	28.00	34.44
BIRMINGHAM		
No. 2 Foundry (silicon 2.25 @ 2.75)	*22.50@23.00*	27.00
PHILADELPHIA		
Eastern Pa., No. 2X (2.25@2.75 sil.)	24.25	33.76
Virginia No. 2 (silicon 2.25 @ 2.75)	28.17	34.17
Basic	24.00	31.00
Gray Forge	24.00	31.00
CHICAGO		
No. 2 Foundry Local (silicon 1.75 @ 2.25)	24.50	32.00
No. 2 Foundry Southern (silicon 2.25 @ 2.75)	27.00	33.01
PITTSBURGH, including freight charge from the Valley		
No. 2 Foundry Valley (silicon 1.75 @ 2.25)	25.77	31.00
Basic	25.77	31.00
Bessemer	26.77	31.00

SCRAP—The prices following are per gross ton paid to dealers and producers f.o.b. New York. In Chicago and St. Louis the quotations are per net ton and cover delivery at the buyer's works, including freight transfer charges.

	New York	Chicago	St. Louis
No. 1 railroad wrought	$16.00	$11.50	16@16.50
Stove plate	*12.00*	12.00	16.00
No. 1 machinery cast	*17.00*	16.50	19.50@20
Machine shop turnings	9.00	4.00	12.50@13.50
Cast borings	10.00	5.50	14.00
Railroad malleable	16.00	12.50	21.00
Re-rolling rails	14.00	13.00	21.50@22
Re-laying rails	.....	30.00	28.00@31
Heavy melting steel	*13.00*	16.00	.....

RAILWAY SUPPLIES

STEEL RAILS—The following quotations are per ton f.o.b. Pittsburgh and Chicago for carload or larger lots. For less than carload lots 5c. per 100 lb. is charged extra:

	Pittsburgh				
	Apr. 3	One Year Ago	Birmingham	Chicago	St. Louis
Standard bessemer rails	$43.00	$43.00	.....	$43.00	$46.00
Standard openhearth rails	43.00	43.00	$43.00	43.00	46.00
Light rails, 8 to 10 lb.	40@43	43@45	2.00*	43.00	2.55*
Light rails, 12 to 14 lb.	40@43	43@45	2.00*	43.00	2.45*
Light rails, 25 to 45 lb.	40@43	43@45	2.00*	43.00	2.35*
Rerolled Rails	**39**@40	42@45	.....	.....	2.10*

*Per 100 lb.

RAILWAY TIES—For fair-sized orders, the following prices per tie hold:

	6 In. x 8 In. by 8½ Ft.	7 In. x 9 In. by 8½ Ft.
Chicago, White Oak	$1.70	$1.90
Chicago, Hardwood and Red Oak	1.35@1.45	1.50@1.70
Chicago....Empty Cell Creosoting (add'l)	.50	.60
San Francisco..... Green Douglas Fir	.84	1.14
San Francisco, Empty Cell Creosoted Douglas Fir	1.70	2.25
St. Louis, White Oak	1.30	1.60
St. Louis (creosoted) (zinc treated)	1.70	2.05
St. Louis, Red Oak, plain	1.20	1.50
St. Louis, Sap pine-cypress	1.05	1.35

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh for carload lots, together with the warehouse prices at the places named:

	Pittsburgh				San Francisco	Birmingham
	Apr. 3	One Year Ago	Chicago	St. Louis		
Standard spikes, ⅝-in. and larger	*$3.00*@3.15	$3.15	$3.00	$3.85	$4.70	$3.72
Track bolts	4.00@4.25	4.00@4.50	4.00	*3.90*	5.95	4.57
Standard section angle bars	2.75	2.75	2.75	3.45	4.00	3.20

PIPE

WROUGHT PIPE—The following mill discounts are to jobbers for carload lots on the latest Pittsburgh basing card:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
¼ to 3	62	50½	¼ to 1½	30	13

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

¼ to 1½	60	49½	¼ to 1½	30	14
2 to 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

WROUGHT PIPE—From warehouses at the places named the following discounts hold for steel pipe:

	Black		
	New York	Chicago	St. Louis
¼ to 3 in. butt welded	48%	50%	49%
2½ to 6 in. lap welded	44%	47%	46%
	Galvanized		
	New York	Chicago	St. Louis
¼ to 3 in. butt welded	34%	37%	36%
2½ to 6 in. lap welded	30%	34%	33%

Malleable fittings, Classes B and C, banded, from New York stock sell at list plus 4%; class A, plus 23%. Cast iron, standard sizes, 34% off.

CAST-IRON PIPE—The following are prices per net ton for carload lots:

	Birmingham Mill	Pittsburgh	New York Apr. 3	New York One Year Ago
4 in.	*$72.00*	**$66@68**	*$66.60@68.60*	$62.00
6 in. and over	*48.00*	**61.60@63.60**	61.60@63.60	57.50
		Chicago	St. Louis	San Francisco
4 in.		$60.20@64.20	**$59.60**	**$64.00**
6 in. and over		57.20@60.20	54.60	**60.00**

Gas pipe and Class "A," $5 per ton extra.

CLAY DRAIN TILE—The following prices are per 1000 lin.ft.:

	New York					
Size, In.	Apr. 3	One Year Ago	St. Louis	Chicago	San Francisco	Dallas
3	$45.00	$45.00	$50.00	$62.50	.....	.....
4	55.00	55.00	50.00	75.00	$76.50	*$76.50*
5	80.00	80.00	.....	100.00	97.75	*97.75*
6	105.00	105.00	85.00	175.00	127.50	*127.50*
8	170.00	170.00	195.00	187.50	212.50	*212.50*

SEWER PIPE—The following prices are in cents per foot for standard pipe in car load lots, f.o.b., except as otherwise stated:

Size, In	New York Delivered	Pittsburgh	Birmingham	St. Louis	Chicago	San Francisco	Dallas
3	.....	$0.105	.....	.....	$0.15	$0.12	.....
4	.....	.105	$0.11	$0.1175	.15	.15	$0.15
5	.....	.1575	.1375	.....	.23	.18	.18
6	$0.24	.1575	.165	.1645	.23	.21	.21
8	.38	.245	.26	.26	.35	.30	.325
10	.57	.3675	.338	.364	.53	.42	.476
12	.72	.4725	.442	.468	.68	.54	.612
15	1.13†	.63	.65	.78†	.90	.90	.384
18	1.65†	.875	.85	1.092†	1.25	1.32	1.153
20	1.98†	1.05	1.125	.....	1.50	.....	.....
22	2.64†	1.40	1.375	1.456†	2.00	.....	1.564
24	2.97†	1.575	1.625	1.872†	2.25	2.16	2.04
27	4.81†	2.795	.....	2.95†	4.69†	3.00	3.34
30	5.33†	3.096	.....	3.65†	5.94†	3.60	4.06
33	6.93†	4.14	.....	4.45†	6.88†	.....	4.99
36	7.91†	4.715	.....	4.80†	7.50†	.....	5.42

	3	5	8	12	24	36
Boston	$0.129	$0.198	$0.305	$0.595	$1.99†	$5.97†
Minneapolis	.....	.....	.40	.72	2.55†	5.66†
Denver	.135*	.18*	.27	.47	1.70	.....
Seattle	.13	.....	.36	.72†	2.60†	.....
Los Angeles	.13	.165	.275	.475	1.65	.....
New Orleans	.145*	.168*	.28	.476	1.182	.....
Cincinnati	.111	.1665	.259	.4995	1.665	4.92
Atlanta	.11*	*.135**	*.225*	*.3825*	*1.4625*	.....
Montreal	.68‡	.45†	.70	1.35	4.50†	
Detroit	.108	.162	.252	.486	2.205†	5.8425†
Baltimore	.117	.175	.273	.5265	1.755	3.9975
Kansas City, Mo.	.15*	.21*	*.33*	**.60**		
Philadelphia	.12	.18	.28	.54	1.80	5.2275

*4-in., 6-in., 9-in., respectively. †Double Strength. ‡3-in. special.

ROAD AND PAVING MATERIALS

ROAD OILS—Following are prices per gallon in tank cars 8,000 gal. minimum f.o.b. place named:

	Apr. 3	One Year Ago
New York, 45% asphalt (at terminal)	$0.053	$0.05
New York, 65% asphalt (at terminal)	.051	.05
New York, binder (at terminal)	.06	.0575
New York, flux (at terminal)	.04	.055
New York, liquid asphalt (at terminal)	.048	.06
St. Louis, 40@50% asphalt	*.048*	.055
St. Louis, 50@60% asphalt	*.049*	.06
Chicago, 40–50% asphalt	.0525	.0525
Chicago, 60–70% asphalt	.055	.055
Dallas, 45% asphalt	.0495	.04
Dallas, 55% asphalt	.0455	.048
Dallas, binder	.061	.053
San Francisco, binder, per ton	9.50*	9.50*

* F.o.b. Oelum, Cal. Freight to San Francisco, 80c. per ton.

ASPHALT—Price per ton in packages (350-lb. bbls. or 425-lb. drums) and in bulk in carload lots, f.o.b. points listed:

	Package	Bulk
New York (*Texas and Mexican*)	$21.20	$16.70
Boston (*Mexican*)	*21.50*	*16.50*
Chicago (*Standolind*)	21.00	15.00
San Francisco, *f.o.b. refinery*, Oleum, Cal.	17.00	11.00
Dallas (*Texas*)	27.10	21.10
Seattle, "*D*" *grade, California, f.o.b. Richmond*	24.75	20.50
Denver (*California*)	24 00	
Minneapolis *f.o.b. Twin Cities* (*Standolind*)	25 10	19 10
St. Louis (*Trinidad*)	32 50	28 50
Baltimore (*Standard Oil*)	18.00	14.00
Montreal (*Imperial*)	28.00	21.00
Atlanta (*Mexican*)	31.50	28.00
Detroit (*Mexican*)	22 00	18 00
Cincinnati (*Kentucky Rock*)	17.50	13.50
Maurer, N. J. (*Bermudez*)	28.00	26.00
Maurer, N. J. (*Mexican*)	20.50	17.50
Philadelphia (*Mexican*)	20.00	17.00
Kansas City (*Texas*)	27.30	22.30
Los Angeles "*D*" *grade, California, f.o.b. El Segundo Refinery*	17.00	11.00

NOTE—Barrels or drums are optional in most cities. About 6 bbls. to the ton, and from 4 to 5 drums; 200 to 300 gal. to the ton.

PAVING STONE—

New York (grade 1)	5-in. granite, 30 blocks per sq.yd.	$148.50 per M.
Chicago	About 4x8x4 dressed	3 60 per sq.yd.
	About 4x8x4 common	2.95 per sq.yd
San Francisco	Basalt block 4x7x8	70.00 per M.
Boston	5-in. granite, 28 blocks per sq.yd.	130.00 per M.
Atlanta	Granite	2.66 per sq.yd.
Detroit	5-in. Granite	3.00 per sq.yd.
Baltimore	Granite	2.85 per sq.yd.
Montreal	Granite	104.75 per M.
New Orleans	Granite, 4 x 8 x 4	3.25 per sq.yd.
Cincinnati	Granite	138.00 per M.
St. Louis	4x8x4 dressed	*1.75* per sq.yd.
	4x8x4 common	*1.75* per sq.yd.
Kansas City	Granite	3.85 per sq.yd.
Philadelphia	Granite	*3.90@4.25* per sq.yd
Minneapolis	Sandstone	2.74 per sq.yd.

FLAGGING—

New York	Bronx, 4 ft wide	$0.22 per sq.ft.
	Manhattan, 4 ft. wide	.22 per sq.ft.
	Queens, 5 ft. wide	.24 per sq.ft.
	6x24-in. cross-walk	1.10 per lin.ft.
Chicago	18 in. wide ...No market	.... per lin.ft.

CURBING—*New York*: Bluestone per lin.ft., f.o.b. barge New York, 5 x 16 in., 85c.; 5 x 20 in., Queens, 85c. *St. Louis*: Class "A" straight, delivered, 5 x 16 in., *$1.10* per lin.ft.

WOOD BLOCK PAVING—

	Size of Block	Treatment	Per Sq.Yd
New York (*delivered*)	3	16	$2 29
New York (*delivered*)	3½	16	2 56
Boston	3½	18	2 65
Chicago	4	16	3 20
Chicago	3½	16	2 90
St. Louis	3½	16	*2 50*
St. Louis	4	16	*2 80*
Seattle	4	16	Off market
Minneapolis	3½	16	2 75
Atlanta	3½	16	2 00
New Orleans	3	16	2 50
New Orleans	3½	16	*2 80*
New Orleans	4	16	3 15
Dallas	4	18	3 90
Baltimore	3½	16	None used
Montreal	4	16	4 50
Detroit	3	16	2 84
Detroit	4	16	3 00
Cincinnati	3½	16	2.38
Kansas City	4	16	3 00
Philadelphia	4	16	None used

CONSTRUCTION MATERIALS

SAND AND GRAVEL—Price for cargo or carload lots to contractor is as follows, per cu.yd.:

	Gravel 1½ In. Apr. 3	Gravel 1½ In. One Year Ago	Gravel ¾ In. Apr. 3	Gravel ¾ In. One Year Ago	Sand Apr. 3	Sand One Year Ago
New York (*alongside dock*)	$2 00	$2.25	$2.00	$2.25	$1.25	$1.00
Denver	1.90	1 90	1.90	1.90	1.00	1.00
Chicago	2.00	2.25	2.00	2.25	2.00	2.25
St. Louis	1.45†	1.45†	1.45†	1.65†	1.20	1.45†
Seattle	1.50	1.25	1.50	1.25	1.50	1.25
Dallas	2.38	2.25	2.38	2.25	2.00	1.87½
Minneapolis	1.85*	1.75*	1.85*	1.75*	1.25-1.50	1.00
Cincinnati	1.35†	1.50†	1.35†	1.50†	*1.20*†	1.25†
San Francisco	2.15	2.15	2.15	2.15	1.50	1.50
Boston	*1.35*†	1.40†	*1.35*†	1.40†	*1.05*†	1.10†
New Orleans	2.85	2.85	2.85	2.85	1.25	1.85
Los Angeles	*2.15*		*2.20*		*1.70*	
Atlanta	2.00†	1 90†	2.00†	1.90†	1.40†	1.24†
Detroit	2 05	2.25	1.75	2.25	*1.35*	2.00
Baltimore	1.40	1.86	1.60	2.06	0.70†	0.70†
Montreal	1.25†	1.25†	1.50†	1.50†	1.25†	1.25†
Birmingham (Crushed slag used instead of gravel)					*1.14*†	1.25†
Philadelphia	2 00	1.85	*2.00*	1.95	*1.50*	1.90
Kansas City		1 60†		1.60†	0.66*	0.66*

New York—Grits, $1.75 per cu. yd.; ready mixed, $2.00
Los Angeles—Freight from quarry, 70c. per ton, and is included in above price.
* At pit.
† Per ton

CRUSHED STONE—Price for cargo or carload lots f.o.b. city, unless stated otherwise, is as follows, per cu.yd.:

	1½ In. Apr. 3	1½ In. One Year Ago	¾ In. Apr. 3	¾ In. One Year Ago
New York	$1.75	$1.65	$1.85	$1.75
Chicago	2.00	2.25	2.00	2.25
St. Louis	1.75	2.00	1.75	2.10
Dallas	2.83	2.50	2.83	2.50
San Francisco	2.15	2.15	2.15	2.15
Boston	*1.45**	1.85*	*1.45**	1.85*
Minneapolis	1.85	2.00	2.00	2.25
Kansas City	1.50	1.50	1.50	1.50
Denver	3.50	3.50	3.50	3.50
Seattle	3.00	3.00	3.00	3.00
Atlanta	2.00*	2.00*	2.00*	2.00*
Cincinnati	1.75*	1.75*	1.75*	1.75*
Los Angeles *delivered*	3.00	1.00	3 10	3.00
Detroit	1.75	1.60@1.90*	1.75	1.60@1.90*
Baltimore	2.50	2.37	2.50	2.43
Montreal	1.80*	1.80*	1.90*	1.90*
Philadelphia	*2.10*	1.80*	*2.10*	1.65*
Pittsburgh	2.85	2.85	2.85	2.85
Cleveland	3.25*	3.25*	3.25*	3.25*

*Per ton.

CRUSHED SLAG—Price of crushed slag in carload lots, per net ton, at plants:

	1½-In.	¾-In.	Roofing	Sand
Youngstown District	$1.30	$1.40	$2.00	$1.30
Steubenville District	1.40	1.40	2.00	1.40
Ironton District	1.40	1.40	2.00	1.40
Easton, Catasauqua, Pa	0.85	0.90	2.50	
Birmingham, Ala	1.05	1.15	2.05	0.80
Buffalo, N. Y., and Erie, Pa	1.25	1.25	2.25	1.25
Cleveland, Ohio	1.45	1.45	1.45	1.25
Eastern Pa. and Northern N. J	1.20	1.20	2.50	1.20
Western Pennsylvania	1.25	1.25	2.00	1.25
Longdale and Glen Wilton, Va	1.25	1.25	2.50	1.00
Toledo, Ohio	1.50	1.50	1.50	1.50

LIME—Warehouse prices:

	Hydrated, per Ton Finishing	Hydrated, per Ton Common	Lump, per Barrel Finishing	Lump, per Barrel Common
New York	$18 20	$13.10	$3.75*	$3.00@3.25*
Chicago	20 00	20.60	1.50†	1.50†
St. Louis	20 00	19.00	18.75‡	
Boston	26 50	*15.00*	*4.00**	3.00*
Dallas	20 00			1 85†
Cincinnati	16 80	14.30	....	13 40‡
San Francisco	22 00			2 10†
Minneapolis	25 50	21.00 (white)	1.70†	*1.50*†
Denver	24 00		....	2.70†
Detroit	22 00	20.00		20.00‡
Seattle, *paper sacks*	24 00		2 80†	
Los Angeles		18 50		2.00†
Baltimore	24.25	17.85	2 55	
Montreal	21.00	21.00		9 50‡
Atlanta	22.50	14.00	2 25†	1 65†
New Orleans			2.40†	1 85†
Philadelphia	23.00	16.00	1.93*	1 24†
Kansas City	18 40	18 40	3.92*	2 57*
Birmingham	14 50	13.75	2.00†	1 80†

*Per 280-lb. bbl. (net). †Per 180-lb. bbl. (net). ‡Per ton—Refund of 10c per bbl. Minneapolis quotes brown common lump lime; Kelly Is white is $1.80. Sheboygan $1.70. New York quotes hydrated lime "on cars" in paper sacks; lump lime "alongside dealers docks" or "on cars."

NATURAL CEMENT—Price to dealers per bbl. for 500 bbl. or over, f.o.b. exclusive of bags:

	Apr. 3	One Year Ago
Minneapolis (Rosendale)	$2 80	$2 80
Kansas City (Ft. Scott)	1 80	1 50
Cincinnati (Utica)	1 72	1 72
Boston (Rosendale)	2 70	2 60
St. Louis (Carney)	*1 95*	1 75
Birmingham (Magnolia) pozzolan cement	2 10	

PORTLAND CEMENT—Prices to contractors per bbl. in carload lots f.o.b. points listed *without bags*. Cash discount not deducted.

	Apr. 3	One Month Ago	One Year Ago
New York, del. by truck	$2.50@2.60	$2.50@2.60	$2.70@2.80
New York, alongside dock to dealers	2.15	2.15	2.30
Jersey City	2.33	2.33	2.48
Boston	2 65	2.63	2.75
Chicago	2.20	2.20	2.20
Pittsburgh	2.19	2.19	2.24
Cleveland	2.39	2.39	2.46
Detroit	2.40	2.40	2.47
Indianapolis	2.41	2.31	2.41
Milwaukee	2.35	2.35	2.37
Duluth	2.19	2.19	2.14
Peoria	2 37	2.27	2.41
Cedar Rapids	2.40	2.40	2.48
Davenport	2 39	2.42	2.43
St. Louis	2.20	2.20	2.35
San Francisco	2.61	2.61	2.71
New Orleans	2.40	2.40	3.30
Minneapolis	2.42	2.42	2.39
Denver	2.84	2.84	2.85
Seattle	2.90	2.90	2.90
Dallas	2.05	2.05	2.25
Atlanta	2.35	2.35	2.90
Cincinnati	2.47	2.37	2.54
Los Angeles	3.00	3.00	3.40
Baltimore	2.50	2.50	2.61
Birmingham	*2.65*	2.80	2.50
Kansas City	2.38	2.10	2.42
Montreal	2.72	2.72	2.88
Philadelphia	2.41	2.41	2.41
St. Paul	2.42	2.42	2.39
Toledo	2.40	2.40	2.48

NOTE—Bags 10c. each, 40c. per bbl.; 20c. each in Canada, 80c. per bbl.

Current mill-prices per barrel in carload lots, without bags, to contractors:

Buffington, Ind	$1.95	Hudson, N. Y	$2.00
Universal, Pa	1.95	Leeds, Ala	1.95
Steelton, Minn	2.00	Hannibal, Mo	1.95
Fordwick, Va	2.05	Lehigh Valley District	1.95
Mitchell, Ind	1.95	Wyandotte, Mich	2.15
Iola, Kan	1.95	Alpena, Mich	2.00
Mason City, Ia	2.00	Richard City, Tenn	2.05
La Salle, Ill	1.95	Kingsport, Tenn	2.05

TRIANGLE MESH—Price per 100 sq.ft. in carload lots:

PLAIN 4-INCH BY 4-INCH MESH

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh Mill	Chicago Mill	Warehouse: New York	St. Louis	Dallas	San Francisco
032	22	$0 95	$1 02	$1 24	$1.04	$1 12	$1 21
049	28	1 20	1 30	1 58	1.32	1 38	1 52
068	35	1 47	1 59	1 94	1.62	1 67	1 87
093	45	1 89	2 04	2 50	2.08	2 00	2 42
126	57	2 34	2 53	3 09	2.59	2 55	3 07
153	68	2 79	3 02	3 60	3.08	3 15	.....
180	78	3 20	3 47	5 22	3.54	3 47	.....
245	103	4 22	4 57	4 60	4.66	4 58	.....
287	119	4 88	5 28	6 44	5.39	5 26	6 25
336	138	5 66	6.13	7 39	6.25	6 11	.....
395	160	6 56	7 10	8 67	7.25	7 12	.....
			PAVING				
036P	17	$0 72	$0 78	$0.95	$0.79	$0.76	.....
053P	24	1 02	1 10	1 35	1.12	1 07	.....
072P	31	1 29	1 40	1 71	1.42	1 39	.....
097P	40	1 66	1 80	2 20	1.83	1 90	.....
049R	24	.....	1 10	.....	1.12	1 07	.....
067R	31	.....	1 40	.....	1.42	1 39	.....
089R	40	.....	1 80	.....	1.83	1 90	.....

In rolls, 48-, 52-, and 56-in. wide and in 150-, 200- and 300-ft. lengths. Galvanized is about 15% higher. Size of roll carried in New York warehouses, 48 in. wide x 150 ft. long, or 600 sq. ft.

EXPANDED METAL LATH—Prices in carload lots per 100 yd. for painted are as follows:

Weight in pounds	New York	Chicago	St. Louis	San Francisco	Dallas
2 2	$22 00	$19 00	$20 00	$19 00	$25.50
2 5	22 00	21 00	21 00	21.50	27 58
2.8	22 00	22 50	24 50	.....	30 71
3 0	24 00	24 50	26 50	23.00	33 16
3 4	27.00	26 50	29 00	.....	35 10

BARS, CONCRETE REINFORCING—Current quotations per 100 lb.:

ROLLED FROM BILLETS

Inches	Pittsburgh Mill	Birmingham Mill	Warehouse, Uncut: New York	Chicago	St. Louis	Dallas	San Francisco
½ and larger	$2 40	$2 70	$3 54	$3 20	$3.35	$3 38	$3 65
⅝	2 45	2 80	3 64	3 25	3 45	3 43	3 75
¾	2 50	2 90	3 74	3 30	3 55	3 48	3 85
⅞	2 65	2 95	3 94	3 45	3 75	3 63	4 05
1	2 90	3 00	4 54	3 70	4 35	3 78	4 65

For size and cutting extras, manufacturers and distributers, see bar card of July 1, 1923.

ROLLED FROM RAILS

	Chicago	St. Louis	Dallas		Chicago	St. Louis	Dallas
½ and larger	$2 30	$3.05	$3 08	1	$2 70	$3 30	$3 30
⅝ in	2 40	3 10	3 13	1¼	3.30	3 50	5 48
¾	2 50	3.15	3 18		.....	.....	.....

BRICK—Contractors price per 1,000 in cargo or carload lots is as follows:

	Common: Apr. 3	One Month Ago	One Year Ago	Paving Block: 3-inch*	4-inch*
New York (del.)	$23 65	$23.65@25.85	$23.50	$46.50	$54 00
New York (at dock)	20.00	20@22	20.00	.....	.....
Chicago	11 00	11 00	11 00	34 00	42 00
St. Louis, salmon	16@18	16@18	15@17	38@40	40@42.50
Denver, salmon	12.00	12 00	12 00	.....	.....
Dallas	13.60	11 60	11 60	35.00	.....
San Francisco	15.50	15 50	15.00	.....	.....
Los Angeles	14.50	14 50	15.00	(not used)	
Boston (del.)	21.50	22.00	20 00	48.25	56.00
Minneapolis (del.)	14.50	16@18	17@19	.....	.....
Kansas City	16.50	16.50	16 50	(no market)	
Seattle	15 00	15 00	13 00	.....	58.50
Cincinnati	17 00	17.00	18.00	40.00	45 00
Montreal	17.50	17 50	16 50	100.00‡	68 00
Detroit (del.)	17.50	17.50	20.00	38 50	41.50
Baltimore (del.)	21.00	21.00	19.20	40.00	45.00
Atlanta	12.00	12 00	13.00	40.00	45 00
New Orleans	18 75	18 75	17 25	.....	.....
Birmingham	12.50	12.50@14.00	12.50	.....	.....
Philadelphia	21 00	21.00	19@25	38.00	46.00
Pittsburgh (del.)	16.00	16.00	16.00	.....	.....
Cleveland	16.00	16.00	16.00	.....	.....

* For paving blocks 3½x8½x3 and 3½x8½x4 respectively. † F.o.b. ‡Imported.

HOLLOW TILE—Price per block in carload lots to contractor for hollow building tile.

	New York: Apr. 3 on Trucks*	New York: One Year Ago	Chicago	Philadelphia	St. Louis	San Francisco	Perth Amboy N. J., Factory*
4x12x12	$0 1179	$0.1314	$0 064	$0.125	$0 078	$0.108	.....
6x12x12	.1769	.1971	088	.....	.106	156	.....
8x12x12	.2211	2463	.12	.215	14	244	$0.1968
10x12x12	.....	.....	1511	.....	165	.....	.2442
12x12x12	.....	.....	176	.....	.21	.....	.3175

* 5 per. off for cash.

	4x12x12	8x12x12	12x12x12
Boston	$0.125	$0.23	.....
Minneapolis (f.o.b. cars)	07	.12	$0.20
Minneapolis (delivered)	075	13	.21
Cincinnati	.07485	.13745	.....
Kansas City	.086	.158	.....
Denver	065	123	188
Seattle (delivered)	11	25	.36
Los Angeles	0931	1686	.....
New Orleans	12	23	.....
Detroit (delivered)	1044	1958	2737
Montreal	115	225	30
Baltimore	125	.27	.....
Atlanta	091	1516	.....
Dallas	11	.20	285
Birmingham	11¶	18	.....
Pittsburgh (delivered)	.068	.128	.179
Cleveland	.08	.164	.....

San Francisco and New York quote on hollow partition tile.

STRUCTURAL MATERIAL—Following are base prices f. o. b. mill, Pittsburgh and Birmingham, together with quotations per 100 lb. from warehouses at places named:

	Pittsburgh Mill	Birmingham Mill	Warehouse: New York	Dallas	St. Louis	Chicago	San Francisco
Beams, 3 to 15 in	$2.40@2.50	$3 00	$3 64	$4 40	$3.45	$3.30	$3 60
Channels, 3 to 15 in	2.40@2.50	3 00	3 64	4 40	3.45	3.30	3 60
Angles, 3 to 16 in., ¼ in thick	2.40@2.50	3 00	3 64	4 40	3 45	3.30	3 60
Tees, 3 in. and larger	2.40@2.50	3 00	3 64	4 40	3 50	3.30	3 60
Plates, ¼ in. thick and heavier	2.40@2.50	3 00	3 64	4 40	3 45	3.30	3 60

RIVETS—The following quotations are per 100 lb.:

STRUCTURAL

	Warehouse: Pittsburgh Mill	New York: Apr. 3	New York: One Yr. Ago	Chicago	St. Louis	San Francisco	Dallas
½ in.	$2.75	$4 40	$4.00	$3.75	$3 90	$5 00	$4 90
CONE HEAD BOILER							
½ in	$3 00	$4 50	$4 10	$3 85	$4.10	$5 20	$5.00
⅝ and ¾	3.15	4.66	4.26	4.00	4.45@4.60	5 35	5.15
⅞ and 1	3.40	4.90	4 50	4.25	4 85	5 60	5.40

NAILS—The following quotations are per keg from warehouse:

	Pittsburgh Mill	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	$3.00	$3 80	$4.15	$4 55	$3.55	$4 95
Cut	3.15@3.25	4 45	5 25	5 75	3.59	5 00

SHIP SPIKES—Current prices per 100 lb.:

In.	San Francisco: Galv.	San Francisco: Black	Seattle Black
½	$8.25	$6.20	$7.00
⅝	7 80	5 80	5.50
¾	7 65	5.15	5.25

Pittsburgh base in lots of 200 kegs or more, $3.25@3.50.

PREPARED ROOFINGS—Slate-surfaced roofing (red and green) in rolls of 108 sq.ft. costs $2 71 per roll to consumers in less than carload lots f.o.b. Philadelphia.

Single shingles, red and green slate finish, cost $6.95 per square (sufficient to cover 100 sq.ft.) in less than carload lots, f.o.b. Philadelphia. Strip shingles (4 in.) f.o.b. Philadelphia, l.c.l., $6.10 per square.

ROOFING MATERIALS—Prices f.o.b. New York, to consumers in less than carload lots:

Tar felt (14 lb. per square of 100 sq.ft.) per ton	$78 02
Tar pitch (in 400-lb. bbl.), per 100 lb	2 04
Asphalt roofing (in barrels), per ton, f.o.b. plant*	38.75
Asphalt felt (light), per ton, f.o.b. plant*	87.75
Asphalt felt (heavy), per ton, f.o.b. plant*	87.75

* Delivered in Metropolitan Dist., $2.00 additional.

WINDOW GLASS—United inches, 25, bracket size 6x8 to 10x15, single thickness "AA," 82 per cent; "A," 86 per cent; "B," 88 per cent. Double thickness "AA," 82 per cent; "A," 85 per cent; "B," 88 per cent discount from jobbers list at New York warehouses.

SHEETS—Quotations are per 100 lb. in various cities from warehouse also the base quotations from mill:

Blue Annealed	Pittsburgh Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10	$2.90@3.00	$4.10	$4.00	$5.00	$4.34
No. 12	3.00@3.10	4.15	4.05	5.05	4.39
No. 14	3.10@3.20	4.20	4.10	5.10	4.44
No. 16	3.30@3.40	4.30	4.20	5.20	4.54
Black					
*Nos. 18 and 20	3.70	4 80	4.70	5 60	4 65
*Nos. 22 and 24	3.75	4 85	4.70	5.65	4.70
*No. 26	3.80	4 90	4.75	5.70	4 75
*No. 28	3.85	5.00	4.85	5.80	4 85
Galvanized					
No. 10	3.90@4.00	5 00	4 85	5.50	4 90
No. 12	4.00@4.10	5 10	4 95	5 60	5 00
No. 14	4.00@4.10	5 10	4 95	5.60	5 00
Nos. 17 to 21	4.30@4.40	5 40	5.25	5 90	5.30
Nos. 22 and 24	4.45@4.55	5 55	5 40	6.05	5.45
*Nos. 25 and 26	4.60@4.70	5 70	5 55	6 20	5.55
*No. 28	4.90@5.00	6.00	5 85	6 50	5.85

*For painted corrugated sheets add 30c. per 1,000 lb. for 5 to 28 gage; 25c. for 19 to 24 gages; for galvanized corrugated sheets add 15c., all gages.

LINSEED OIL—These prices are per gallon:

	New York: Apr. 3	New York: One Year Ago	Chicago: Apr. 3	Chicago: One Year Ago
Raw in barrels (5 bbl. lots)	$0.95	$1.13	$0.94	$1.15

WHITE AND RED LEAD—In 100-lb. kegs, base price in cents per pound:

	Dry		In Oil	
	Apr. 3	1 Yr. Ago	Apr. 3	1 Yr. Ago
Red	15.00	14.25	16.50	15.75
White	15.00	14.25	15.00	14.25

LUMBER

Prices wholesale, per M. ft. b.m., to dealers in carload lots, f.o.b.

San Francisco—Prices of rough Douglas fir No. 1 common, in carload lots to dealers at yards. To contractors, $2 per M. ft. additional.

	6-8 and 12 Ft.	10-16-18 and 20 Ft.	22 and 24 Ft.	25 to 32 Ft.
3x3 and 4	$35.00	$36.00	$37.00	$40.00
3x6 and 8	35.00	36.00	37.00	40.00
4x4-6 and 8	35.00	36.00	37.00	40.00
3x10 and 12	35.00	36.00	37.00	40.00
3x14	39.00	39.00	41.00	43.00
4x10 and 12	35.00	36.00	37.00	40.00
4x14	39.00	39.00	41.00	43.00

	24 Ft. and Under	25 to 32 Ft.	33 to 40 Ft.
6x10	$37.00	$39.00	$41.00
6x14	38.00	40.00	42.00
8x10	37.00	39.00	41.00
8x14	38.00	40.00	42.00

New York and Chicago—Wholesale prices to dealers of long leaf yellow pine.

	New York*		Chicago	
	20 Ft. and Under	22-24 Ft.	20 Ft. and Under	22-24 Ft.
3x4 to 8x8	*$47.00*	*$46.00*	$42.00	$44.00
3x10 to 10x10	*52.00*	*51.00*	47.00	50.00
3x12 to 12x12	*59.00*	*58.00*	55.00	57.00
3x14 to 14x14	*64.00*	*63.00*	61.00	63.00
3x16 to 16x16	*68.00*	*67.00*	69.00	71.00
3x18 to 18x18			79.00	81.00
4x20 to 20x20			89.00	91.00

*Wholesale price to dealers; to contractors, delivered from lighters or cars to job, $5 additional. Short leaf pine costs $3 per M. less.

Over 24 ft.—Add $1 for each additional 2 ft. in length up to 30 ft. for sizes 12 x 12 and under, for sizes over 12 x 12 add $2, for merchantable add $2 to sizes 10 x 10 and under.

Other Cities	8x8-In. x 20 Ft. and Under				12x12-In. 20 Ft. and Under	
	P.	Fir*	Hemlock	Spruce	P.	Fir*
Boston	$58.00	$68.00†	$52.00	$52.00	$75.00	$90.00†
Seattle	.....	29.50	.....	.....	.....	*38.00*
New Orleans	**30.00**	.....	.....	.....	42.00	.....
Baltimore	33.50	53.00	53.00	60.00	38.00	53.00
Cincinnati	40.00	74.00	74.00	88.00	44.00	78.00
Montreal	50.00	58.00	.....	.....	.....	65.00
Los Angeles	.....	49.00	.....	.....	.....	50.00
Denver	.....	40.75	40.75	40.75	.....	41.75
Minneapolis	*42.00*	*42.75*	40.00	.....	*45.10*	*45.75*
Atlanta	36.00	.....	.....	.....	40.00	.....
Dallas	**55.00**	.....	.....	.....	**60.22**	.....
Kansas City	*45.50*	48.50	.....	.....	*54.50*	49.50
Birmingham	*25@28*	.....	.....	.....	*29@32*	.....
Philadelphia	49.00	42.00	43.50	48.00	60.00	43.00
Detroit	*38.75*	48.75	.....	.....	**58.75**	48.75
St. Louis	42.00	.....	.....	.....	54.00	.....

	1-In. Rough, 10 In. x 16 Ft. and Under			2-In. T. and Gr. 10 In. x 16 Ft.	
	P.	Fir*	Hemlock	P.	Fir*
Boston	$48.00	$54.00†	$45.00	$56.00	$62.00†
Seattle	.....	25.00	.....	.....	29.00
New Orleans	72.00	.....	.....	**34.00**	.....
Baltimore	60.00	44.00	44.00	34.00	50.00
Cincinnati	75.00	80.00	75.00	38.00	88.00
Montreal	56.00	50.00	45.00	45.00	45.00
Los Angeles	.....	**49.00**	.....	.....	.....
Denver	.....	*35.25*	*35.25*	.....	**32.75**
Minneapolis	*45.00*	*38.25*	*36.50*	*39.00*	*35.25*
Atlanta	24.00	.....	.....	34.00	.....
Dallas	**55.00**	.....	.....	**58.66**	.....
Kansas City	**80.50**	46.00	.....	**77.50**	.....
Birmingham	*21@23*	.....	.....	*29@33*	.....
Philadelphia	33.00	42.00	43.00	50.00	41.00
Detroit	*43.25*	39.00	.....	*45.50*	41.00
St. Louis	*41.00*	.....	.....	*30.00*	.....

Birmingham—Quotes carload lots, f.o.b. sidings; $4.00 additional per M.ft. to contractors.
Boston and Cincinnati—Prices to contractors in carload lots, f.o.b.
Denver—Quotes dealers price to contractors on large projects.
St. Louis—Wholesale price to contractors, f.o.b. cars, $3 per M.ft. additional.
Seattle—Price to contractors, delivered.
Dallas—Wholesale to contractors, $10 per M.ft. additional.
*Douglas fir. †Prime.

PILES—Prices per lineal foot, pine piles with bark on, f.o.b. New York.

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.14½	$0.18½
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.23½
12 in.—2 ft. from butt	6 in.	60 to 69 ft	.21½	.25½
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.25½	.34
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.27½	.36½
14 in.—2 ft. from butt	5 in.	80 to 89 ft.	.35	.41

MISCELLANEOUS

STEEL SHEETPILING—The following price is base per 100 lb. f.o.b. Pittsburgh, with a comparison of a month and a year ago:

Apr. 3	One Month Ago	One Year Ago
$2.65	$2.65	$2.30@2.70

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized are as follows:

	Eastern Territory New York and East of Missouri River
Hercules red strand, all constructions	20%
Patent flattened strand, special steel wire rope	20%
Patent flattened strand, iron rope	5%
Plow steel round strand rope	35%
Special steel round strand rope	30%
Cast steel round strand rope	20%
Round strand iron and iron tiller	5%
Galvanized steel rigging and guy rope	7½%
Galvanized iron rigging and guy rope	+12½%

California, Oregon, Nevada and Washington Discount: 5 points less than discount for Eastern territory.
Wyoming, New Mexico and Colorado: Discount 5 points less than discount for Eastern territory.
Arizona: Discount 10 points less than discount for Eastern territory.
Montana, Idaho and Utah: Discount 10 points less than discount for Eastern territory.
North Dakota, Nebraska, Kansas, Oklahoma and Texas: Discount 5 points less than discount for Eastern territory.

MANILA ROPE—For rope smaller than ¾-in. the price is ½ to 2c. extra; while for quantities amounting to less than 600 ft., there is an extra charge of 1c. The number of feet per pound for the various sizes is as follows: ¼-in., 8 ft., ½-in., 6; ⅝-in., 4½; ¾-in., 3½; 1-in., 2 ft. 10 in.; 1¼-in., 2 ft. 4 in. Following is price per pound for ¾-in. and larger, in 1200-ft. coils:

Boston	$0.15½@.18	New Orleans	$0.17½
New York	.19½	Los Angeles	.20
Chicago	.18	Seattle	.18
Minneapolis	.19½	St. Louis	.18½
San Francisco	.17	Montreal	.22
Atlanta	.23½	Detroit	.20
Denver	.20½	Baltimore	.18
Cincinnati	.21	Kansas City	.19½
Dallas	.21	Birmingham	.20½
Philadelphia	.17		

EXPLOSIVES—Price per pound of dynamite in small lots:

	Gelatin 40%	Gelatin 60%
New York	$0.27	$0.295
Boston	.23	.25
Kansas City	**.2275**	**.2475**
Seattle	.165	.19
Chicago	.22	.25
Minneapolis	.1917	.2123
St. Louis	.22	.245
Denver	.2025	.2275
Dallas	.225	.302
Los Angeles	.1975	.2225
Atlanta	.23	.255
Baltimore	.22	.23
Cincinnati	*.2125*	.2325
Montreal	.195	.235
Birmingham, *delivered*	.16	.17
New Orleans	.195	.22
San Francisco	.1625	.1925
Philadelphia	.215	.24

CHEMICALS—Water and sewage treatment chemicals, spot shipments in carload lots, f. o. b. New York:

Sulphate of aluminum, in bags, per 100 lb.	$1.40@1.50
Sulphate of copper, in bbl., per 100 lb.	**4.85@5.00**
Soda ash, 58%, in bags, per 100 lb.	1.25@1.45
Chlorine, liquid, cylinders, 100 lb., per lb. (f.o.b works)	.05½@.07½
Hypochlorite of lime (bleaching powder) in drums, per 100 lb.	**2.25@2.35**

FREIGHT RATES—On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant steel, bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carloads of 36,000 lb.:

Baltimore	$0.31	Detroit	$0.29
Birmingham	.58	Kansas City	.735
Boston	.365	New Orleans	.67
Buffalo	.265	New York	.34
Chicago	.34	Pacific Coast (all rail)	1.15*
Cincinnati	.29	Philadelphia	.32
Cleveland	.215	St. Louis	.43
Denver	1.26	St. Paul	.60

* Minimum carload, 50,000 lb., structural steel only; 80,000 lb., for other iron or steel products.